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ARMY ORDNANCE

VOL. V WASHINGTON, D. C., MAY-JUNE, 1925 No. 30

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Leaders of American Industry and Officials of Army Ordnance Aboard the "Los Angeles" Making an Aerial Survey of the Philadelphia Ordnance District, May 15, 1925

GENERAL SUMMERALL URGES INDUSTRIAL PREPAREDNESS BEFORE NEW YORK POST, A. O. A.

THE MILL INSPECTION OF STEEL
By Charles McKnight, Jr.

IMPROVED QUALITY STEEL PRODUCTION
By Emil Gathmann

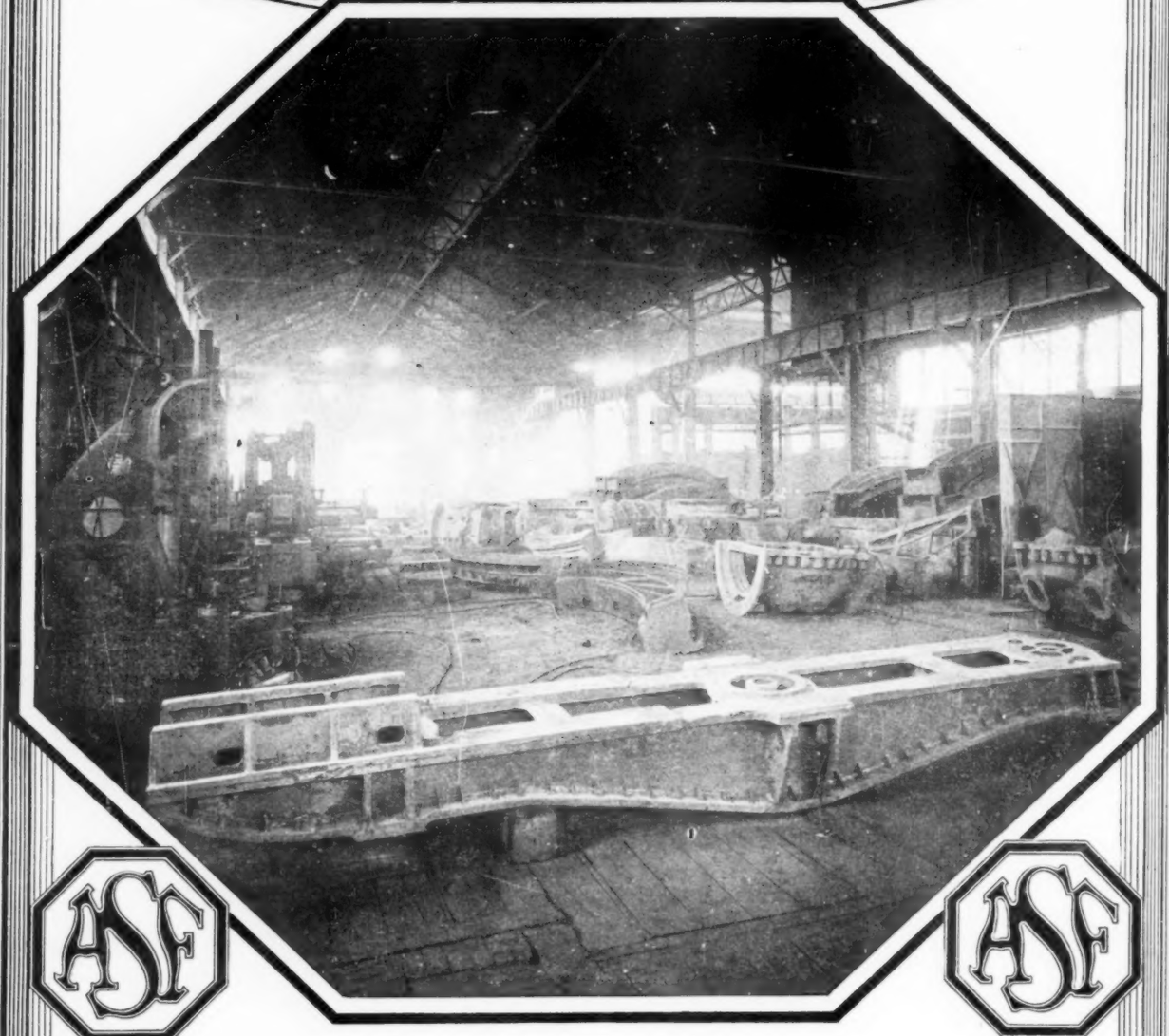
MODERN SMALL ARMS AND THEIR MANUFACTURING REQUIREMENTS
By Glenn P. Wilhelm

SYMPOSIUM: CARBURIZATION A FACTOR IN MACHINE GUN BARREL EROSION

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

AMERICAN STEEL FOUNDRIES

NEW YORK CHICAGO ST. LOUIS



STEEL CASTINGS OF EVERY DESCRIPTION
FOR
ARMY AND NAVY REQUIREMENTS

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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MAJ. GEN CHARLES P. SUMMERALL, U. S. A.
Commanding General, Second Corps Area

"In modern war munitions are a far greater and more difficult problem than men."—General Summerall.

General Summerall Urges Industrial Preparedness Before New York Post, A. O. A.

ON Monday evening, April 6th, the annual dinner and meeting of the New York Post of the Army Ordnance Association was held at the Army and Navy Club in New York City, at which the principal address was made by Maj. Gen. Charles P. Summerall, Commanding General of the Second Corps Area.

A leading figure in the World War and one of the foremost advocates of preparedness in America today, General Summerall urged the utmost cooperation of industry with the industrial preparedness plans of the War Department which are now being made in accordance with the National Defense Act of 1920.

General Summerall said:

"It is an unusual honor and a privilege to be permitted to appear here today before this group of representative business men of this city and country. It is a privilege which touches me very deeply. And my whole thought is one of appreciation and gratitude to the gentlemen who were courteous enough to invite me to be present, and to Judge Gary for the very gracious manner in which he has presented me to you.

"As a newcomer to this city, or as a new resident I might say, for I have been coming here for many years, I do feel most fortunate in the associations that I have been able to establish, largely through the kindness of Judge Gary and gentlemen like him who are interested in the nation as well as in the business of this great city.

"These are anniversary days. It is not hard for us to look back a few years when, in the beginning of April, 1917, the whole country realized it was on the brink of a great abyss, when the nation was to take a plunge for which every thinking man knew it was totally unprepared, and the result of which the bravest would not even have dared to predict. In sitting here today and listening to the addresses, beginning with that of Judge Gary, all breathing patriotism and the spirit of service, I can but repeat what has been misinterpreted in my remarks so often, that good as well as evil has come out of the great tragedy through which the nation passed, and we call it war. Much good has come. We are better people, we are finer citizens, we are a better government, we are doing more for ourselves, for our fellow men and for the world than we ever could have done but for that ordeal which regenerated our people spiritually when they passed through it.

"The addresses have so thoroughly embraced the subject which is of interest to us all that there really remains but little that anyone could say. From the remarks that have been made, however, I think we may deduce certain basic principles pertinent to the angle of national defense in which you are especially interested. And the first and foremost is that in modern war munitions are a far greater and more difficult problem than men. And the next is that it is not the resources of a nation from which success must be derived alone; it is the organization, the development and the assembly of those resources which will make victory possible in the initial stages of a campaign. And a third, that in war business and the Government are one; whatever they may be in peace, however war may affect business in itself, in war all differences disappear, business and the Government are one. And to apply these principles so as to make them effective the impulses must come from the top, from the leading men in industry. I think if we could observe and indoctrinate those ideas we would have no difficulty in mobilizing our resources and preparing this country to sustain itself in its dignity and in its destiny before the world.

"If I might touch briefly upon some of the elements involved: we know too well the staggering problem presented to us about munitions in the initial days, the initial months of the war. It was the experience everywhere. Paris was protected with all of the power of France, not because it was the capital or the chief city—if those had been the only reasons Paris could have been abandoned. The heart of the munitions industry of France was in Paris and its environs. If Paris were lost munitions would cease to exist and the war would come to a speedy end. Several reasons have been given why the German army failed in its initial campaign, which should have been successful; and more and more it is coming to light that munitions, and not the lack of men, was the reason for the great defeat in the first Battle of the Marne. It is true the world over, it is true with us, and we must not for one moment ignore the fact that munitions—not men—are our great problem in modern war; we have the men and we can get them, but we have not the munitions and we cannot get them unless we are prepared to supply them.

"The great German plan of campaign, as we all know, included a speedy march and a quick victory. It matters not what the resources of France might have been, with their assembled munitions and men to overwhelm the armies in the first stages of the war, victory was complete and lasting. We are in danger of a great fallacy in this country; we are told that we are one of three nations of the world which have the resources for a protracted war. They will not serve us in a protracted war if we are defeated in the first stages of the war. On the contrary they will become the prize of the victors over us. Our great coal and metal supply and our great factories are of no value to us after we are defeated; they become an asset of the enemy.

"There grew up in the campaign a saying among the fighting men that in the face of death all men are equal. I cannot imagine anything that is truer or more logical or more inspiring—in the face of death all men are equal. And every one must give what is in him in his own place,

even to his life, for the good of his country. If that is true, gentlemen, of the fighting man, must it not also be true of the man who enables him to fight. Can there be any difference between our government and our industries in business?

"We are now trying to pay off a great debt, the greatest on earth I believe; certainly it is the most stupendous in our history. As logical thinking men we should not have a debt of that magnitude, it is wrong for us ever to have subjected ourselves to such a situation. If business and the Government unite, which they must do, as General Tripp and General Cartier so profoundly and wisely said, business cannot profiteer off the Government, nor can the Government impose on business; without the Government there can be no business; they will stand or fall together. Business must sustain the Government in time of war by giving it all that it has, and it must in time of peace be prepared to give the Government all that it has; because only by the support of the Government can business live; just as only by standing together in the battle line can men save their own lives as well as bring victory. If we are to attain these we can reach them only by one method, and that is by having the leading, dominant men of our country adopt them and apply them. The great mass of the people must follow the leaders; they do it in politics, they do it in religion, and they do it in industry.

"The spirit that has been disclosed here today and which has been disclosed continuously for the last few years, of the great financiers, the captains of industry as we have been proud to call them, like those represented here today in Judge Gary and General Tripp and so many others, is the greatest hope of the country today in fortifying itself against the hour of danger.

"Colonel Walsh has touched lightly but convincingly upon the necessity of our being prepared. And the need is greater perhaps than even you gentlemen realize. The spirit of the pacifist, or whatever he may be called, of defeat, of surrender, of giving up, is abroad in the land. It is not in the spirit of an alarmist that I again say that we are struggling desperately to hold the little nucleus of an army, and a navy perhaps, and the military asset of a few trained officers and men; and our hold is very feeble.

"During the past week or ten days I have been inspecting the fortifications of this great city, the richest spot on earth, the place that sends the throb through this country and through the world, the starting point of many of our great enterprises today, this great City of New York. And it fills one with sadness. We wonder if we are still a going forward and an onward people! The forts built for the protection of this city, with their guns and their emplacements abandoned substantially; no men to serve them; and there they stand as a sermon to us, telling us that in the days of virility and strength of our people we planted here before this great city, at the gateway to its wealth and its resources, a defense which, whether you know it or not, has strengthened the hands of our diplomats and has exercised an influence that perhaps is beyond our calculations in the discussion of international questions. And today they are unmanned!

"Gentlemen, there is need for what you are doing here. And this is no idle meeting that you are attending. We perchance can get men, but we must go on with our preparations to use those men. We cannot prepare in a month or a day; it takes time and the forethought that Colonel Goodrich has outlined. And as one who has given his thoughts and whatever services were possible to the safeguarding of this nation, I want to tell you that in my heart I am grateful to you for being here and for what you have done, and implore you to go on with it, organize your industries, prepare to do your part in sustaining the country, just as the fighting man must do when he goes and if necessary gives his life."

The meeting of the New York Post was held on the eighth anniversary of the declaration of war with Germany and was the occasion for one of the largest gatherings in the history of the Post. General Guy E. Tripp, Chairman of the Westinghouse Electric and Manufacturing Company, who was Chief of the Production Division of the Ordnance Department during the World War, presided and made the following introductory remarks:

"You are loyal American citizens and that is saying a good deal but you are also practising citizens and that is saying much more. There is the same distinction to be drawn in citizenship that there is in religion. A man who accepts the benefits and protection of law and order under this government and then washes his hands of all responsibility and says he does not believe nor want to believe in its institutions, is no more valuable as a factor in preserving our democracy than a number in the telephone book, however acceptable he may be to himself and to his family. One of the great problems which is now being solved is that of a sane and safe defensive military organization which shall not be burdensome at home nor dangerous to the lasting peace of the world. This great question is of paramount importance and it has troubled statesmen for centuries, and now a preparedness plan has been inaugurated which permits our utmost cooperation with other nations in disarmament on the one hand and insures us against utter helplessness in case of attack on the other.

"It answers all the objections which can reasonably be raised against militarism or reckless government expenditure of money.

But it must be supported by the voluntary unpaid services of the citizen. You are giving this service; therefore, I introduce you to yourselves as patriotic men, valuable men—wise men—unselfish men—and, briefly, just men spelled in capital letters."

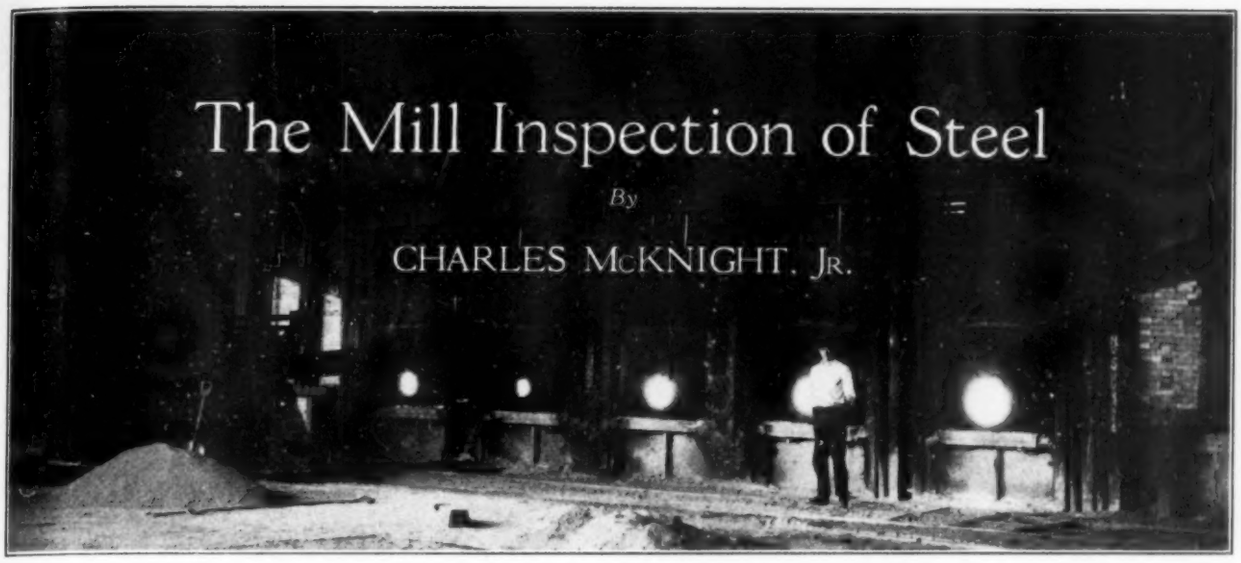
The meeting was also addressed by Brig. Gen. John Ross Delafield, former chief of the New York District Ordnance Office, and now President of the Reserve Officers Association, who described the work of that organization in furthering adequate preparedness.

Immediately after the dinner, the following officers of the New York Post were elected for the ensuing year: *President,* Gen. Guy E. Tripp; *Vice Presidents,* Col. James L. Walsh, Col. T. L. Ames, Lt. Col. H. B. Machen, Lt. Col. R. D. Coombs; *Secretary,* Capt. H. W. Churchill; *Treasurer,* Capt. J. B. Fidlar; *Executive Committee*: Gen. Guy E. Tripp, Chairman; Col. James L. Walsh, Vice Chairman; Col. T. L. Ames, Mr. James A. Farrell, Col. C. E. Warren, Lt. Col. H. B. Machen, and Lt. Col. R. D. Coombs, Maj. Earl McFarland, Capt. H. W. Churchill, Maj. C. E. Davies, Mr. E. R. Stettinius, Lt. Col. E. L. Sherwood, Maj. J. M. Boyle, Capt. J. B. Fidlar; *Program Committee*: Col. James L. Walsh, Col. T. L. Ames, Lt. Col. H. L. Sherwood, Maj. C. E. Davies; *Membership Committee*: Gen. Guy E. Tripp, Mr. James A. Farrell, Lt. Col. F. W. Roller, Lt. Col. R. D. Coombs, Lt. Col. H. B. Machen, Lt. Col. C. F. Judson, and Maj. J. M. Boyle.

The Mill Inspection of Steel

By

CHARLES McKNIGHT, JR.



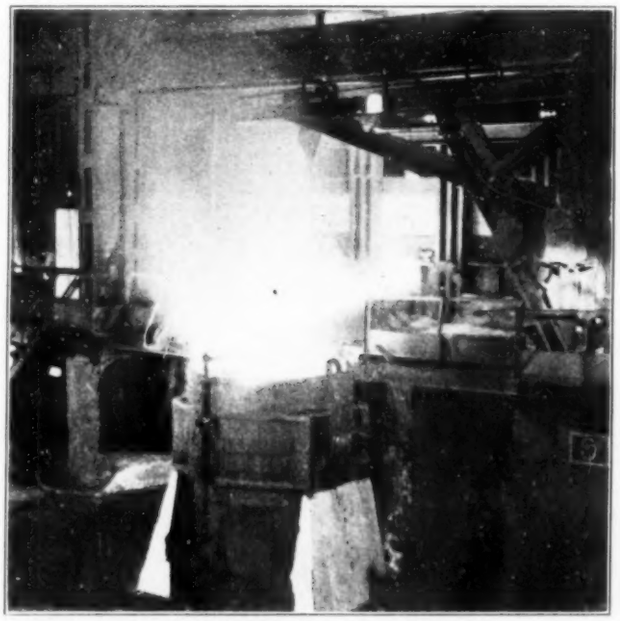
An Open Hearth Furnace

BY definition, inspection is the act of holding a careful, critical investigation. Unfortunately—or perhaps fortunately for our peace of mind—when inspecting steel it is impossible to make absolutely certain of the quality of steel without destroying it. But by careful inspection of product and control of processes it is possible to foretell with reasonable accuracy the quality and performance of a certain piece or certain heat of steel. It is the duty and the function of the inspector to make the careful, critical investigation called for and cull out that which will not be suitable.

Though simple by definition, the position of inspector is one that requires technical skill, good judgment and a fundamental knowledge of the manufacture and uses of steel. It is also important that he should have the ability to work in an efficient, peaceful way with the mill operating force, and this requires a high degree of tact and diplomacy. The inspector is always in the unenviable and unappreciated position of umpire, either between the operating department and the specifications, so to speak, or actually between the manufacturer and the purchaser of the steel.

In addition, an inspector is called upon to use his discretion to an unusual extent and his most valuable characteristic will generally be a supply of good common sense. In the recent business depression a metalurgist for one of the steel companies was repeatedly called on to inspect some defective steel at a customer's plant. Since steel from the same heat had given consistently good results, it was rather puzzling suddenly to begin to receive complaints about hard spots, slag inclusions, cracked bars, etc. The inspector, who had some knowledge of underlying economic conditions, developed by judicious questioning that the customer had been able to replace this steel, bought at peak prices, with material which had been almost given away during the slump by another manufacturer. Consequently, he ordered the remaining steel in question returned, allowing credit based on current prices with a subsequent adjustment to be made if complete examination showed the steel to be defective. This examination showed nothing to be the matter and the steel was placed in a broker's hands, and he ultimately sold it to the original customer who used every pound of it without knowing where it came from and without any difficulty. Naturally, their later claim for an adjustment was not substantiated.

The inspection of steel may be that performed by the manufacturer or by the user. As a general rule, it may be stated that the inspection by any reputable mill is of more value than that done by the purchaser or user, because more information is available to the former and it is to his best interests to have no rejections by the purchaser. It is often far cheaper for the manufacturer to scrap and remelt an entire heat than it is to let it get out in the trade and become "commuting" steel—commuting back and forth between the mill, customer and scrap heap—and therefore the relation of the inspector to the metal is best expressed by "Merton of the Movies" in his characterization of his wife as "his best pal and, at the same time, his severest critic."

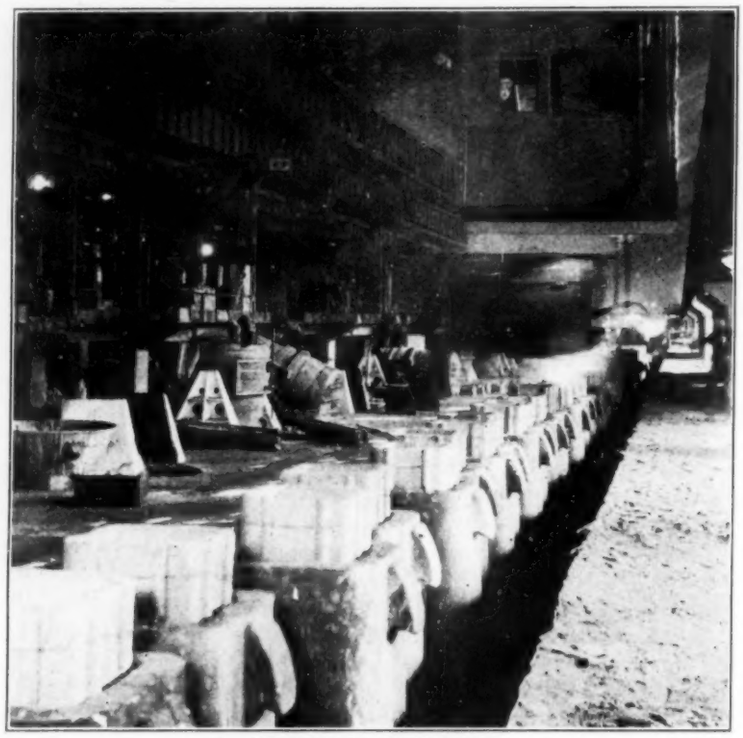


Tapping 100-Ton Open Hearth Furnace

The inspection department, besides being one of the most important in a mill, is also an expensive one, the figures from a mill engaged in the manufacture of high grade alloy and tool steels showing that

this concern, having a relatively small output of about 7,500 tons per month, pays for control and inspection a total of about $4,000 per month. In a larger plant the number of men employed by the chemical, metallurgical and inspection departments is well over fifty.

In order to present a clear picture of the methods of inspection and the function of the inspector, it is preferable to follow the steel in elemental detail through the processes of manufacture and the inspection noted at each stage, rather than to take up each defect and its detection in haphazard manner.



Pouring Alloy Steel Ingots

Specifications

When an order comes from a customer, the specification usually follows the standard form of one of the technical societies, such as the American Society for Testing Materials or the Society of Automotive Engineers, and there are three main requirements. These are the chemical analysis, the physical characteristics—such as elastic limit, ultimate tensile strength, percentage of elongation and reduction of area—and that "the material shall be free from injurious defects and shall have workmanlike finish." The latter brief discretionary clause is bristling with teeth and provides a wide field for discussion through lack of agreement on what constitutes an "injurious defect" or "unworkmanlike finish."

The control and inspection thus necessitated begin with the raw materials which enter into the composition of the metal. As these are received they are sampled and analyzed and it sometimes requires rare judgment on the part of the sample boy to select a representative sample, as, for example, to pick out one or two average pieces from a carload of miscellaneous railroad scrap containing everything from old airbrake hose to journal brasses. In spite of this, very accurate results are obtained and a constant check kept on the metals, refractories, fuels and slag materials as they are consumed. During the actual steel making the melter from time to time as the heat progresses takes a small spoonful of metal and pours it into a test mold. This piece is then broken and from the fracture the furnaceman is able to tell the carbon content within a few hundredths of one per cent and whether abnormal amounts of manganese, phosphorus or sulphur are present. Toward the end of the heat, drillings are taken from a similar test piece and sent to the laboratory for a "preliminary" test. In from ten minutes to a half hour, depending on the chemist, the carbon and manganese content (and perhaps nickel and chrome) are accurately reported and on the basis of this report the melter finishes his heat, makes the necessary additions and taps out.

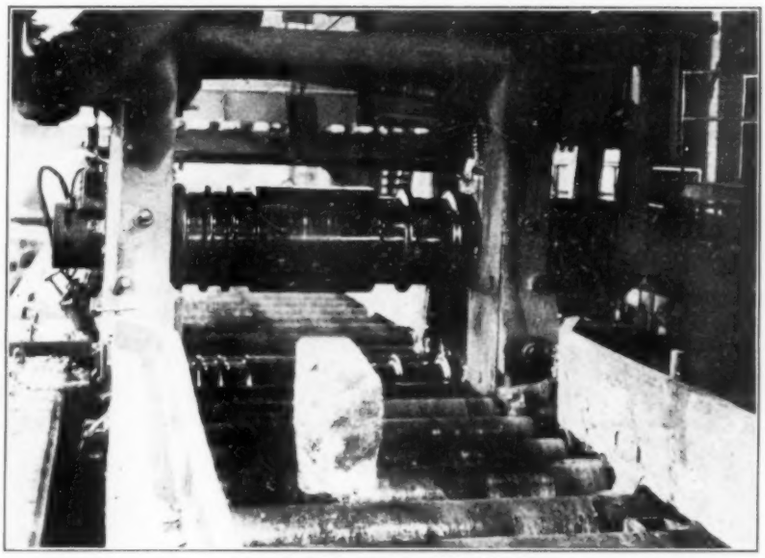
While the steel is being teemed from the ladle to the molds there is no inspection as such, but either the open hearth superintendent or melter watches with care to see that the metal is not teemed too rapidly or too hot, conditions that tend toward cracks, and poor ingot structure, and in many plants a check on the temperature is made by means of an optical pyrometer. When the ladle is about half empty the stream is diverted momentarily to fill a small test mold about 1½ inches square by 5 inches long, the ingot from which is drilled and analysed. This analysis is observed as the official heat analysis and results show remarkably small variations between the composition of this small test piece and the heat as a whole.

The Ingot

After the ingots have cooled sufficiently, which requires in good practice as long a period as four hours, depending on their size, they are stripped from the molds and inspected for obvious surface defects. If any exist to a detrimental extent, that ingot is scrapped. These defects may arise from many sources, as the time from the tapping of the steel to the stripping of the ingots is the most critical stage in the manufacture of steel. During this stage there become apparent such evils as piping, blowholes, segregation, non-metallic inclusions, cracks, ingotism, etc. A few years ago attention was directed at this phase of steel making and there has resulted the general adoption of the sand or tile hot-top to reduce piping, and the big-end-up mold. The combination of the two, provided the mold is also well designed as to thickness of wall, corners and bulge in the sides, represents the furthest advance in that line today. Coincident with this development has come a better understanding of the use of deoxidizing agents, finishing and teeming temperatures, proper ingot cooling, re-heating and stripping. Yet even now it is safe to say that the greatest advances in steel making in the near future will have to do with this transitional stage.

It is not in the province of this article to go extensively into the nature of the defects which result in this phase but it may not be amiss to at least define and describe them. Piping is a cone shaped cavity, small end down, in the top portion of the ingot which is caused by the contraction of the steel as it solidifies and which varies in size with the type of ingot-mold and condition of the

steel. It may exist throughout the greater part of the ingot length or may be almost nonexistent. Blowholes are smaller cavities formed by bubbles of gas in the metal and are the main source of seams. Nonmetallic inclusions, quite generally referred to as "sonims," are particles of dirt, slag, etc., entrapped in the metal and of varying size and frequency of occurrence. Cracks, either on the surface or as internal discontinuities are as often the result of bad or sloppy pouring practice and of contraction of the hot and soft ingot center away from the more rigid exterior as from faulty heating of the ingot preparatory to rolling. Scabs on ingots which later roll into surface irregularities, such as "slivers," are caused by metal splashing during teeming against the cold mold wall where it solidifies and is later incorporated in, but not welded to, the ingot. "Segregation" is the term applied to that condition in an ingot which renders it nonuniform in composition. It is influenced by the progressive solidifying of the steel and consequently that portion which is last to freeze shows most segregation. Fortunately, segregation and piping occur to a large extent simultaneously, and are both dealt with by cropping, as outlined later. Ingotism is a peculiar coarse chrystalline structure with definite planes of weakness. It may result from either poor mold design or improper teeming or a combination of the two.



Blooming Mill at Alloy Steel Plant

A mold pull is caused when the ingot is not free to contract in a longitudinal direction, so that the soft metal tears open. It most frequently occurs through "hanging" in the mold, i. e., the metal is held by the hot-top or a lip of steel over the edge of the mold so that the ingot hangs from this point and is torn by its own weight. Some steels, especially dense and hard, exhibit minute cracks through the center of the ingot. These are usually quite inconspicuous and show up only on an etch test and are obviated only by a combination of good melting and pouring practice, together with careful cooling of both the ingot and blooms, the latter being quite usually buried in ashes to insure slow cooling.

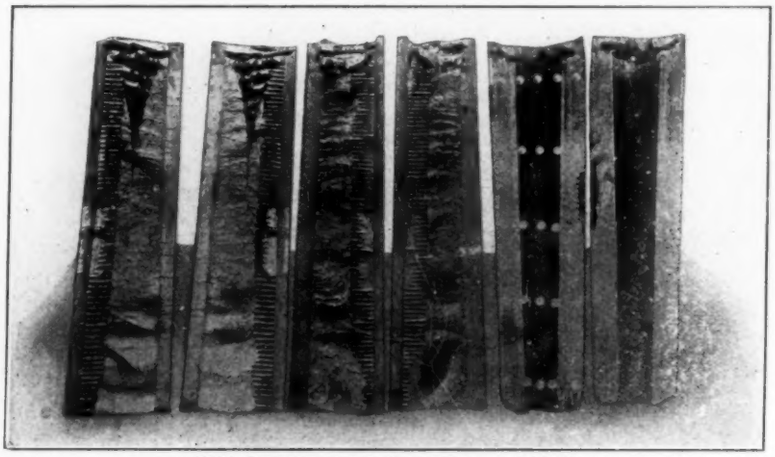
After stripping, and generally while still hot, the ingots are heated in soaking pits until there is an equalization of heat through the metal and it is hot enough to be rolled in the blooming and billet mills. If the ingots are allowed to grow cold instead of being charged directly into the pits, care must be exercised in order subsequently not to damage the steel by too quick heating. If the steel is alloy or high carbon it is best either to allow the pit to get black before charging a cold ingot or else to preheat the ingots prior to charging in a special furnace for that purpose.

The blooming and billet mills rapidly reduce an ingot that is perhaps 20 by 20 inches to a bloom 8 by 8 inches and then to a billet 4 by 4 inches on one heating. None of these dimensions are fixed, as practice varies in different mills. On the completion of this preliminary rolling the billets are removed to the shears, where they are cropped and inspected while still hot. The cropping is done primarily to remove all evidences of pipe, but at the same time it eliminates the segregated portion of the ingot, so it is important that there should be an inspector stationed at the shears to observe this operation. The first cut made is usually about 10 per cent of the total length of the bloom or billet and, if evidences of pipe are still seen, successively smaller cuts are made until it is eliminated. It is easier to judge when it is entirely absent than would be thought, when it is considered that the rolling has tended to make the pipe very inconspicuous. When the shear blade cuts, if there is any pipe in the steel it leaves a small depression, or "lip," on the lower edge of the billet which is unmistakable and almost a sure sign of piping or sponginess. Therefore the inspector watches the lower edge for freedom from this lip. Unfortunately there

Chipping Billets

Prior to rerolling most billets are chipped. Alloy steel billets are usually pickled and chipped

is sometimes a condition existing known as "secondary piping," which consists of another and smaller pipe beneath the first and separated from it by a few inches of sound metal. This condition is not common, as it usually results from bad mold design, but when it does exist the shear blade may cut through the solid metal between pipes and give no indication to the inspector of the secondary piping.



Split Ingots from Different Types of Molds

Left: ingot from big-end-down, no hot-top (standard) type of mold. The large pipe cavity and area of segregation are very noticeable; the pipe can be detected fully two-thirds of the ingot length.
Center: ingot from big-end-down, hot-top (Bradford) type mold. Cavity much restricted. The Bradford mold had a thick-walled base tapering to top where there was a tile hot-top, surrounded by a charcoal fire.
Right: ingot from big-end-up, hot-top (Gathmann) type mold, treated with aluminum mold wash. White spots are locations of analysis drillings.

If the shear blades are not properly adjusted or if the metal in the center of the billets is spongy, it occasionally happens that the shear drags some of the center out of the billet, producing an artificial pipe somewhere further back in the billet. Like secondary piping, this is difficult to detect but it may be caught later in the bars. Luckily it does not happen often. As soon as cropping for pipe is accomplished the billets are cut into convenient length and usually a tail crop is taken. This tail crop amounts to about 5 per cent and is taken to eliminate the possibility of spongy and unsound metal, which is prone to occur at this point. The billets are then given a very close inspection for defects of all sorts, and drillings for analysis are sometimes taken from billets representing the top, middle and bottom of one ingot. This is called the "billet check" and is to guard against excessive segregation.

The chief defects that become apparent at this stage are seams, especially in the manufacture of alloy and high grade steels, because they are neither as prevalent nor as harmful in the tonnage grades. These seams may be caused in several ways, but the great majority of them arise from the existence of surface, or skin, blowholes in the ingot. The blowholes are formed immediately beneath the surface and when the ingot is stripped, still hot, and placed in the soaking pit, the oxidizing effect is sufficient to remove the outer skin and lay these holes open, the interior of which becomes coated with oxide. If, by any chance, they exist through this heating operation without becoming oxidized, in the first rolling operation they are opened up and exposed to the atmosphere and the same action takes place. In either case the blowhole, not welding together on account of this oxide, is elongated in the same ratio as the steel and consequently appears in the billet—or even in the finished bar—as a long and narrow fissure in the surface. Seams vary in appearance greatly. Sometimes they run the whole length of the billet or bar and at others they are only a quarter inch or so long. The actual fissure is sometimes open and clear so that the presence of a seam is unmistakable and, on the contrary, it may be covered with scale and open out below the surface, becoming very difficult to locate. No matter what the appearance or where the location is or how small in size, it is essential that all seams be removed either by milling, grinding or chipping with pneumatic hammers before the final rolling process and this removal is getting to be a very important factor of expense in mills today. In alloy steel mills the maximum number of chippers employed has varied from about two hundred to as high as eight hundred. The lowest authentic chipping cost known is in the neighborhood of $2.00 per ton, while in some instances, it runs as high as $25.00 a ton. In one alloy steel mill which produces about 20,000 tons of alloy and special carbon steels per month, the number of chippers employed is about two hundred, though at one time there were almost eight hundred.

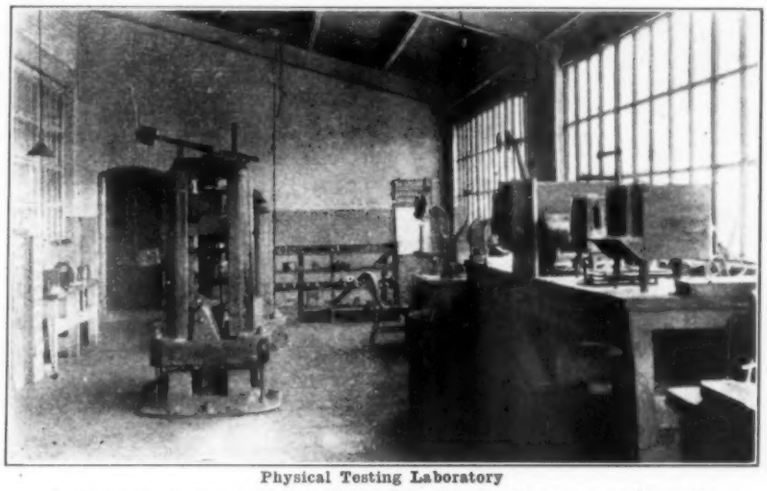
On alloy steels, as well as the steels for some particular purpose, it is becoming general to pickle the billets prior to chipping in a hot solution of sulphuric (or hydrochloric) acid. The advantages are that the troublesome scale is entirely removed before any further hot-working is done and any surface defects, especially seams, are very clearly shown up.

Faults other than seams which are looked for at this time are burned, heavily scaled and torn billets. If the steel has been burned the billet is scrapped, as the metal will be coarse-grained and interlaced with oxide, but heavy scale can be removed by either pickling or chipping. It is rather difficult to describe the difference in appearance between a burnt and a heavily scaled billet but they are not easily mistaken. If the scale is hit with a hammer and falls off in large plate-like pieces leaving the metal surface fairly smooth, the billet has not been burnt. When this has occurred the scale is tight, though heavy, and there appears to be a zone of merging instead of a clean cut separation of oxide and metal. Torn or split billets are caused by too heavy draught, improperly heated or insufficiently deoxidized steel. They can sometimes be rendered usable by chipping but must ordinarily be scrapped. Heavy "ragging" or marking of the rolls to ensure gripping the bloom is sometimes responsible for torn steel.

Assuming that the steel in this intermediate stage has been inspected and passed it next goes to the bar or merchant mills, unless intended for forging purposes. On these mills are rolled the commercial bars used in industry and the number of shapes which can be turned off a good mill is amazing, comprising as it does everything from the simpler rounds, squares and hexagons up to the very intricate special sections. It is here that the inspection is closest and most important. Practice is

different in every mill, but as a rule one inspector is close to the mill and is constantly gaging size and watching for faulty steel in order to inform the roller so that he can remedy in time the condition causing it; the other inspector gives a closer and more leisurely inspection, using frequent tests to confirm his observations.

In regard to size, the maximum allowable variation is ⅛ inch oversize in rounds from 5 to 8 inches in diameter and the minimum is .007 inch under or oversize in rounds up to ½ inch in diameter, and, of course, allowance must be made for the expansion due to heat. This amounts to approximately .015 inch per inch. The inspector on the mill is equipped with micrometer calipers to check the diameter, taking dimensions on rounds in four places: top and bottom, sides, high shoulder and low shoulder. It is possible to distinguish the side of a bar rolled on a guide mill from the top and bottom by the roll markings on the finished scale, which usually shows the parting of the rolls fairly clearly, thus indicating the two sides. For checking intricate sections he uses a template or two templates, one being the exact size and the other the allowable oversize. A tape is used for measuring the length and a square to check the perpendicularity of the corners on squares and flats.



Physical Testing Laboratory

Left: tensile testing machines; right: Brinell and scleroscope machines for hardness testing, electric furnaces for heat-treating specimens.

Tests

While the duties of this inspector are important, arduous, and require fast work and constant viligance, the second inspector is just as important, as he is responsible for the quality of the steel. To determine this, simple but invaluable tests are in use. For the upset test, a short section is taken, heated in a furnace and reduced in length under the hammer from 30 to 60 per cent, finally appearing as a short, squat biscuit. This treatment will invariably show up, if present, seams almost microscopic in character as well as laps, cracks and other similar surface defects. Another of these tests is the forging test, in which a section of steel six inches to a foot in length is heated and drawn out by forging, the bar being revolved about its longitudinal axis. The steel is then nicked and broken and if piping is present in the bar it will be opened up and made perfectly apparent.

There are two other tests known as the light pickle and heavy pickle—or simply as the pickle and heavy etch. In the first, a piece of steel is immersed in dilute sulphuric acid a few minutes and the scale removed. The surface and all of its existing defects are then plainly visible. The last, or heavy etch, test is a great aid to the inspector and ranks with the upset in value. A short piece is immersed from ten minutes to several hours in a solution of hot dilute sulphuric acid or a mixture of sulphuric and hydrochloric acids, the action being allowed to proceed until the structure of the mental is plainly resolved. It is then easy to observe if the metal is spongy, piped, cracked or filled with slag fibres.

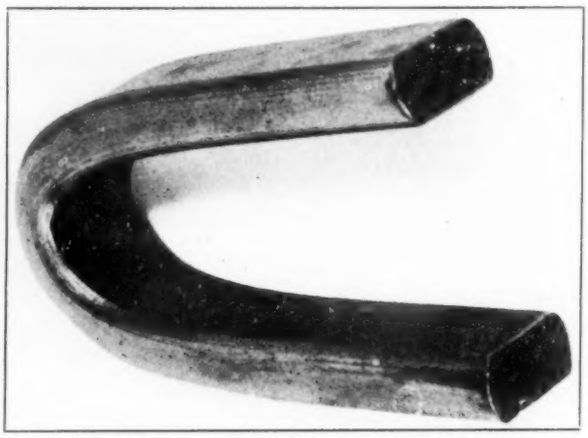
Besides being responsible for the detection of inferior quality of the metal, this second inspector must finally pass on the surface and general appearance. Some of the defects he must watch for are fins or overfills, underfills, kinky or buckled bars, twists, roll marks, laps, seams, fire cracking, piping, slivers, heavy scale, etc. A "fin" or an "overfill" is caused either by improper rolling or roll design. In the rolling of steel the metal is formed in grooves cut in the rolls, the groove in the upper and lower rolls which match being known as a "pass." The relation in area between each pass and the preceeding and succeeding ones is definite, but if it happens that the ratio of reduction is too great the metal is displaced laterally instead of longitudinally and is squeezed in between the rolls. A bar so marked is said to have a "fin" or "overfill" and the imperfection appears as a slight ridge on both sides of the bar. If a bar finned in an intermediate pass is not caught and allowed to go to the next pass where it is rotated 90° the fin will be rolled down onto or into the bar, but not welded to it and is then known as a "lap." An "underfill" is the exact opposite of an overfill—there is not enough metal to fill the pass and the section is correspondingly scant.

If the bar is wavy and down it is "buckled," if sideways it is "kinked"; both of which are usually easily remedied by an adjustment of the rolls. Buckling is sometimes caused by the pinions on the mill which transmit the power intermittently rather than continuously as they should. Also some sections are so heavy on one side and light on the other that they tend to roll off the mill buckled or kinked. "Fire cracking" is a term applied to a peculiar surface which resembles alligator skin in appearance and which is produced by a roll, the outside of which has become cracked or "checked" from the heat. This can only be remedied, if serious enough to cause rejection, by using a new pass and then refinishing the roll.

Occasionally through accident, such as letting a tool pass through the mill, an indentation is made in the roll which produces at regular intervals on the section being rolled a similar protuberance, called a "roll mark," and when this is anything more than a slight marking it is cause for rejection. The same principle is made use of in marking structural steel and rails, the maker's name and year being cut into the rolls. A "sliver" may

be caused by burned or badly finished metal, or by improper placing of the guides which lead the bar into each pass of the mill and it is well described by the term. Guide scratches and tears which result from improperly adjusted guides or too much manipulation of the steel by the guides are similar in appearance to a seam and many complaints of poor steel or incomplete chipping can be remedied in the guides. A "cobbled bar," which is rarely seen outside of a steel mill, is really not a defect but a mill tragedy, as the steel instead of running quietly off the mill, winds around the roll and frequently must be laboriously chipped or burned off when cold. If the cobble is not bad, part of billet or bar may be used. A "twist" is caused by the groove in the upper and lower roll not registering exactly and it is remedied by moving the top roll endwise in the direction of twist. This is of less importance in rolling rounds than in other shapes.

The defects enumerated above have been given in some detail because they are the principal ones occurring not only in merchant mills but most other types of mill. Of course in addition to these, each type of mill has its own peculiar defects, but the work on only one other will be taken up briefly. After bars the biggest single tonnage of steel goes into plates, comprising 12 per cent of the whole. As is generally known, the mill for manufacturing plates bears very little resemblance to those previously discussed, but consists of two extremely large rolls and a third somewhat smaller in diameter. These rolls are twelve feet or more in length, three feet in diameter and made of chilled cast iron. Differing from most mills there are no passes or guides, the diameter of the roll being almost constant, and rolling is done by direct reduction. A modification of this mill known as the universal mill has two or more vertical rolls as well as the horizontal rolls and it is possible with this mill to square up the edges of the plate.



Bend Test on Heat-treated Alloy Steel Casting

On the plate mill the inspector watches for defects before mentioned and in addition for plates which are "laminated," heavy in the center and light on the edges, "snaky," "cambered," "blistered" or "brick marked." A "laminated" plate shows a marked streaky structure and occasionally at the ends and edges has the appearance of a stack of paper, with leaves separating. It is sometimes possible to wedge these layers apart, just like a pack in sheet mill practice and such a plate is rejected.

The rolls of a plate mill are machined slightly larger in diameter in the center so that the plate will be the same thickness throughout its width in spite of the spring in the roll and the greater expansion from heat in the center of it. A plate will sometimes be heavier in the center than on the edges, due to wear of the rolls, and this is cause for rejection if it is too marked. Occasionally also the reverse is true and a plate will be heavy on the edges. A "snaky" plate exhibits marks resembling seams but they are not confined to a direction parallel with the axis of the plate, as they are in bars but wind about helter-skelter. It is not definitely known what causes snakes but it is supposed that they exist through from the ingot and if not too deep or too numerous they are ground out. A "cambered" plate results from a heavier draught on one side of the mill than on the other, or from unequal heating, so that in rolling one side is extended more than the other. A plate of this sort is usable but must be sheared into sizes which will fit. A "blister" is well described by the term and is caused presumably by a blowhole which is not welded up. A "brickmark" comes from the soaking pits and heating furnaces when a piece of furnace walls or bottom becomes attached to the metal and is subsequently rolled into the surface.

While the steel is in process in various departments the routine work of checking is going on simultaneously. The chemical laboratory as a rule furnishes the complete analysis in less than twenty-four hours, unless there are some special elements to be determined. The usual analysis includes carbon, manganese, silicon, phosphorus and sulphur. Almost as common are analyses for nickel, chromium and copper, while every steel laboratory now-a-days can handle vanadium, molybdenum and tungsten. The work of the chemical laboratory is lacking in spectacular features but for rapidity and accuracy it is not surpassed by any other department of the mill, and the methods are being improved upon continually. It was not so many years ago that an accurate carbon determination took so long that preliminaries were not thought of and the condition of the bath was judged by eye from the test piece. Now there is a loud complaint from the open hearth if more than half an hour is consumed in drilling the test piece, weighing the sample, heating it up to red heat, burning off the carbon with oxygen, weighing up the products of combustion, calculating the percentage of carbon and being accurate within two hundredths of one per cent.

While on this subject, it should be added that concurrent with the development of the chemical laboratory in the mill has been the growth in specifying steel by analysis so that at present the "temper number" or the "fracture" is rarely heard of as a method of judging steel for purchase, and even the trade name is fast being abandoned in place of the more scientific and logical method. Not long ago a new tool steel was being introduced by a certain steel company under a trade name as superlative in its terms as usual. One day the head of a tool manufacturing concern happened to be in the plant and this steel was demonstrated to him by the time-honored method of driving a hardened piece through a soft billet. After this the manufacturer was solicited to place his order, but he evaded the question, asked for a sample and departed. Not hearing from him after a lapse of a few weeks he was again approached by the Sales Department to purchase a substantial quantity of this "Double Extra Quality Brand Three Star Hatchet

Steel'' at fifteen cents a pound. The offer was politely declined but accompanying the letter of refusal was an order for a heat of steel ''to the attached analysis.'' The attached analysis proved to be an analysis report which the tool maker had cannily had made on the sample, thus enabling him to buy steel on analysis at about half the price he would have had to pay for the same steel had it been offered him under a trade name.

On the other hand there are others who have not yet grasped the meaning of analyses. It is said that the head of one of the rejuvenated old steel plants was anxious to obtain a contract. He was told by the purchaser that a competitor had agreed to supply this steel, phosphorus and sulphur under .04, for a certain price. ''Hell'' replied the steel man ''I'll furnish you the steel and give you twice as much sulphur and phosphorus for the same price!''

If a physical test is called for, the necessary specimen is taken after final rolling, sometimes by a representative of the purchaser who puts his identifying stamp on it, but more often by the mill inspector. This piece is machined to a standard test piece size and pulled in a tensile machine, the yield point being obtained by the drop of beam method. Concurrently any special tests called for by the customer are taken. These may include the Brinnel or scleroscope test for hardness, tests for resistance to corrosion or for permeability (electric steels), for ductility (like the Erieson test), for welding properties and, in addition, impact tests, fatigue tests and combined impact and fatigue tests.

These impact tests include the Charpy and Izod, where a small test piece is broken by the fall of a heavy pendulum and the energy absorbed by the metal calculated. The fatigue tests are varied in character but in general are simply machines which bend the specimen back and forth, or rotate it under a given load, many thousands or even millions of times until fracture takes place. In the Stanton, or repeated impact, test which is becoming widely used, though it is difficult to interpret the tests, a small grooved test piece is hit a fairly light blow alternately on opposite sides until failure occurs.

One test that is called for a great deal, especially in government work, is the bend test. In this a specimen of the steel is doubled on itself and is usually required to bend cold 180 degrees around a bar whose diameter equals the thickness of the specimen. Sometimes this is modified to require doubling flat on itself or the work is done while hot, to ensure that it is not hot short. This test is considered a failure if the test piece breaks or cracks at the edges of the bend.

Realizing the importance of the microscope and metallographic work, many mills now require that a representative sample of each heat be polished and examined, both unetched and etched, under the microscope as a matter of routine. This is unquestionably a good thing to do and furnishes a check on the steel if used and intrepreted with other tests and is of inestimable value in determining whether or not steel is piped, dirty or full of blowholes, as well as the structural condition. There is still another method of examination that shows great promise of value. This is the radiographic method of photographing through the steel and locating inclusions and blowholes. It is in process of development now, and recently some valuable data have been published on radiographic examinations of steel castings.* However it is improbable that it will ever be used as a routine method on account of the difficulties, dangers and expense attending the use of the X-ray.

(Courtesy: Chapman Valve Mfg. Co.)
Torsional Test Specimen on Heat-treated Alloy Steel Casting

A word of warning to the inspector not to be too hasty to accept or condemn on one test will not be amiss. The acceptance or rejection of a piece of steel should be determined just as a good lawyer determines the guilt or innocence of the accused person. One significant fact alone will not convict or acquit but many of them linked together make a circumstantial chain that is undeniable in force. Recently there occurred the failure of an important stressed part of railway equipment. The investigating metallurgist took a tensile specimen and also made some photomicrographs, using a comparatively high magnification (500 dia.) and a nital etch which was so heavy as to be practically useless. The broken tensile test piece showed to the naked eye at least three glaring faults—dirty steel, internal fissures and evidence of pipe—in addition to having pulled very low in elongation and reduction of area. However, these defects were passed by entirely and the report returned that the failure was due to abnormal grain size on the strength of the photomicrograph alone.

Frequently information is desired as to just what tests, simple and indicative of good steel are feasible for the use of small consumers who do not possess the facilities for properly testing steel. In such a situation dependence can be placed to a great degree on a heavy etch, a light etch and hand-glass examination and the sulphur print. There is no easy method of analysis, except that carbon can be judged by fracture after quenching in water. As above pointed out, the consumer should not be too quick to condemn on the unsupported evidence of the etch tests and a bad appearance should only arouse suspicions to be confirmed by other and more exact tests. Sometimes a heavy etch will produce the most fantastic appearance in the best of steel and it is of course well known that it will show up fiber and forging lines, which might be condemned by the uninitiated.

The sulphur print test which has not been mentioned is worthy of a short description. The bar in question is machined or filed smooth on one end and polished with successively finer grades of emery cloth. Then a sheet of ordinary developing out photographic paper is dipped for a few minutes in a 3 to 5 per cent solution of sulphuric acid and placed on the polished area so that it will be in contact throughout with the metal. After a minute or so the paper is stripped from the steel and will be found marked with numerous brown spots. If the pattern is

*Editor's Note: In this connection see ARMY ORDNANCE, Vol. III, No. 16, page 210, ''Radiography of Metals,'' by H. H. Lester; and Vol. IV, No. 20, page 77, ''Examination of Steel by the X-ray Spectrometer,'' by Harmann H. Zornig.

close and uniform the steel is probably good; otherwise, it should be viewed with suspicion and other tests made.

There is still another etch test which for macroscopic examination has rapidly increased in popularity since 1920 when it was discussed in a Bureau of Standards scientific paper. The specimen for this test must have a fairly good polish, such as obtained by 00 emery or as a result of surface grinding: It is swabbed for several minutes with an aqueous solution of ammonium persulphate and then washed in fresh water, after which the surface will exhibit a particularly good etch, though it is not heavy. It will be found that this process shows up more details, such as chrystalline structure, sponginess, segregation, flow lines and discontinuities, better than etching with other of the more common reagents.

It is probably unnecessary to say that the practical demonstrations of driving chisels through billets and cutting nails with hatchets are more in the nature of tricks than tests. In the same class are the tests made by the promoters for some new dope that "added, to the bath, will make any .30 carbon steel the equivalent of the best high carbon tool steel." It will be discovered upon trial that any good steel of the same analysis can perform the same stunts under the same conditions. During the War a compound of this sort gained considerable publicity, initiated by the backing which it received from a high official in one of the government departments. Strange to say during its brief but brilliant career several well known technical agencies gave it very high recommendations and it was tried out for a number of purposes including naval guns, although as far as the writer was able to determine its sole beneficence was due to an inconsiderable quantity of nickel which was disseminated through the steel. Lost to sight for a few years, it was again in the limelight a few months ago as the revolutionary agent by which one of the steel companies expected to stage a financial comeback.

It should be emphasized that dubious practices are not countenanced by any reputable steel makers. In fact the steel manufacturer is so jealous of his reputation that it often happens his own specifications and inspection are harder to meet than the customer's and the customer is therefore sure of getting certainly as good steel as he orders—perhaps better. Sometimes the purchaser himself is not too particular about ethics. A year or so ago a steel company was asked for the delivery on a certain size bar at a certain and very low price. The customer, requested to furnish the chemical specifications, replied that it was price, not analysis, which was desired. The steel company had in stock in this size only some very high carbon, off-analysis high phosphorus stuff but the customer indicated his willingness to accept it. Being suspicious, before shipment the Sales Department of this company wanted to know the purpose for which the material was to be used and was quite frankly told it was for "bootleg" steering knuckles for replacement in the proverbial "light car"—of all places the one place where a high phosphorus, high carbon steel would not be desirable. Needless to say the material was not shipped.

Spring Meeting, California Post, A.O.A., and San Francisco District War Game

ONE of the most enthusiastic gatherings of ordnance devotees on the Pacific Coast was held at Benicia Arsenal, May 20th, upon the occasion of the Spring Meeting of the California Post of the A. O. A. The meeting was arranged by Mr. P. E. Holt, President of the California Post, assisted by Col. Bruce Cornwall, Chief of the San Francisco Ordnance District, and his Executive Assistant, Major M. L. Brett, Ord. Dept., U. S. A.

Leaving the Transport Dock at Ft. Mason, San Francisco, by special steamer at 8:15 A. M., the members of the Post sailed to Benicia Arsenal where, beginning at 10 o'clock, a program of ordnance demonstrations of the work being done at the arsenal was carried out.

The first portion of the program included the inspection of the small arms repair shops where the members were shown the various operations including bluing and browning of rifles and other small arms, fitting of new barrels and receivers to rifles, star gaging the caliber .30 rifle, and examinations and inspection of Browning and Lewis machine guns.

At 12:30 luncheon was served, after which a short address was given by Major Smith, Commanding Officer at Benicia, who explained the operation of the establishment, its functions and duties. Major C. E. Partridge also addressed the members on the importance of liaison between Army Ordnance Officers, Corps and Division Ordnance Officers in the field.

San Francisco District War Game

THE annual war game carried out under instructions of the Ordnance Office was held by the San Francisco Ordnance District May 10th to May 24th at the District Headquarters at San Francisco. Beginning Monday, May 11th, those who took part in the game, which included among others fifteen Ordnance Reserve Officers called to active duty, participated in a preliminary conference presided over by Major M. L. Brett, Executive Assistant, San Francisco Ordnance District, who discussed the Ordnance Reserve situation in the 9th Corps Area. Major Brett was followed by Col. E. M. Shinkle, Corps Area Ordnance Officer at San Francisco, who discussed recent ordnance developments.

Tuesday and Wednesday, May 12th and 13th, were given over to discussion of a study of the Corps and Division Ordnance duties and the organization of the San Francisco Ordnance District. At the conference on Thursday an address, "Industrial Situation on the Pacific Coast," was given by Major F. T. Letchfield of the San Francisco Chamber of Commerce, while on Friday the gathering was addressed by Dr. W. J. Crook of Stanford University whose subject was "The Steel Industry on the Pacific Coast." From May 18th to May 21st inclusive, the conferences of each day were devoted to discussions of organization and operation of the Artillery Division, the Ammunition Division and the Small Arms Division of the District organization.

Chemistry in War: An 18th Century Viewpoint

By

TENNEY L. DAVIS

CHEMISTRY has been so greatly credited in recent print with providing the resources of war, and so greatly blamed for contributing its horrors, that it is surprising to find the great Dutch physician and chemist, Hermann Boerhaave, giving it the same praise and blame nearly two hundred years ago. After money, Boerhaave considered chemistry to be the chief support of war. But he also arraigned chemistry for making war so destructive to mankind. All the more astonishing to us now is his indictment, for his particular grievance was against black powder.

"It were indeed to be wish'd," writes[1] Boerhaave in his *Elementa Chemiae*, "that our art had been less ingenious, in contriving means destructive to mankind; we mean those instruments of war which were unknown to the ancients, and have made such havoc among the moderns. But as men have always been bent on seeking each other's destruction by continual wars; and as force, when brought against us, can only be repelled by force, the chief support of war, must, after money, be now sought in chemistry.

"*Roger Bacon*, as early as the twelfth century,[2] had found out gunpowder, wherewith he imitated thunder and lightning; but that age was so happy as not to apply so extraordinary a discovery to the destruction of mankind. But two ages afterwards, *Barthold Schwartz*, a *German* monk and chemist, happening by some accident to discover a prodigious power of expanding in some of this powder which had been made for medicinal uses, he apply'd it first in an iron barrel, and soon after to the military art, and taught it to the *Venetians*. The effect is, that the art of war has since that time turned entirely on this one chemical invention: so that the feeble boy may now kill the stoutest hero: nor is there any thing, how vast and solid soever, can withstand it. By a thorough acquaintance with the power of this powder, that intelligent Dutch General Cohorn quite alter'd the whole art of fighting; making such a change in the manner of fortification, that places formerly held impregnable, now want defenders. In effect, the power of gunpowder is still more to be fear'd. I tremble to mention the stupendous force of another powder, prepar'd of sulphur, nitre, and burnt lees of wine; to say nothing of the well-known power of *aurum fulminans*. Some person taking a quantity of fragrant oil, chemically procured from spices, and mixing it with a liquor procured from salt-petre, discover'd a thing far more powerful than gunpowder itself; and which spontaneously kindles and burns with great fierceness, without any application of fire. I shall but just mention a fatal event which lately happened in *Germany*, from an experiment made with balsam of sulphur terebinthinated, and confined in a close chemical vessel, and thus exploded by fire; God grant that mortal men may not be so ingenious at their own cost, as to pervert a profitable science any longer to such horrible uses. For this reason I forbear to mention several other matters far more horrible and destructive than any of those above rehearsed."

On the foregoing passage, Peter Shaw, translator and editor of Boerhaave's work, has added the following note: "On this occasion we cannot omit to admire an instance of a noble and generous principle, in the late king of *France, Louis XIV*. A *Roman* chemist, *S. Poli*, having discovered something of this kind, of prodigious effect, came to *France* in 1702, on purpose to make an offer of it to that prince; who, tho' he was then going to be engaged in a war against a powerful confederacy; yet voluntarily renounced all the advantages of such a secret: handsomely rewarded the inventor, but enjoin'd him to let it perish."

Primitive men fighting with stones and clubs no doubt felt a resentment against the unsportsmanlike conduct of the first enemy who threw sharpened sticks of wood. But they rapidly adopted the use of spears, and, in due course of time, were again annoyed by an adversary who was not content to throw his pointed sticks but shot them with a greater velocity by reason of the elastic force of a bended bow. To use the fighting of the golden days seems to have been largely a matter of brawn, but intelligence and skill were really considerable factors in it. To primitive man it would seem to depend but little upon brute strength; it would appear to be largely a matter of the appliances, armor, weapons, and instruments, which were used. The feeble shepherd boy, David, was able to slay the stout hero, Goliath, by means of a simple physical instrument in the use of which his powerful opponent was not skilled. The advantage has always been with the more intelligent, and improvements in methods of warfare have been due to advances in scientific knowledge. Except for the smoke-pots of the Chinese and the spouting, inextinguishable fire of the Byzantines, improvements in warfare previous to gunpowder were due, not to chemistry, but to physics.

Since the introduction of gunpowder, changes have been in the direction suggested by chemical discovery. Slow burning powder has made rifled artillery possible. The chemistry of steel and that of the com-

1"A New Method of Chemistry: including the History, Theory, and Practice of the Art: translated from the Original Latin of Dr. Boerhaave's *Elementa Chemiae*, as published by himself. To which are added, Notes; and an Appendix, showing the necessity and Utility of Enlarging the Bounds of Chemistry. By Peter Shaw, M. D., F. R. S." 3rd edition. London, 1753. Vol. I, pp. 189-191

2The information here is not correct. Roger Bacon was of the thirteenth century, and Barthold Schwartz is now generally considered to be a myth.

pounds of carbon have given us the tank and the engine which propels the airplane. Physical instruments have made use of chemical energies; the powder has propelled the bullet, the airplane has dropped the high explosive, the depth bomb has shaken the submarine as a cat would shake a mouse, the thing to be accomplished by the means provided by chemistry has been, until recently, a physical change, and the damage to the enemy has been physical.

The present revolution in methods of warfare involves far more than the exploitation of chemistry. War has become more than ever a matter of intelligence. We now attack the enemy, not merely in a physical way, but by every means which an improved understanding of nature has provided for us. We attack him economically and politically, we attack him psychologically by means of propaganda and by other efficacious devices, and we attack him chemically by means of powerful reagents. The resulting horrors are obviously not to be ascribed to psychology and to chemistry, for these are sciences, neither for harm nor for good, but simply for the better understanding of certain aspects of the world in which we find ourselves.

It has been said that "an army travels on its stomach." We cannot have meat unless we have vegetation upon which the animals may feed, and we cannot have vegetation unless there is chemically combined nitrogen in the soil for food for plants. An army then travels upon its nitrogen. While the amount of uncombined nitrogen in the atmosphere is unlimited, the amount of combined nitrogen available for use by plants is frequently meager. Soils require to be fertilized. The greatest accomplishment of chemistry then would seem to be that it has brought mankind into the present Nitrogen Age and has taught him how to fix the nitrogen of the atmosphere in the form of ammonia and nitrates for use in fertilizers.

Without powder and explosives serious physical damage cannot be done to an enemy, the powerful reagents of chemical warfare cannot be brought into play, propaganda and other psychological agents cannot be made effective. Since all useful powders and explosives are manufactured from ammonia or from nitrates as raw materials, it appears that an army fights by means of its nitrogen.

Warfare becomes increasingly a matter of intelligence. While admitting the dependence of intelligence upon heredity, stimulating environment, etc., we find nevertheless that there is a chemical something without which there can be no thinking. Since the gray matter of the nerves and brain is made up of carbon compounds of phosphorus and nitrogen, it appears that without nitrogenous foods there can be no thinking—and an army thinks with its nitrogen.

Whatever may have been the case in Boerhaave's day, in the present Nitrogen Age it is certainly true that "the chief support of war must now be sought in chemistry." It may be that chemistry is more important than money, for without nitrogen we can have no food, no powder, and even no ideas about the matter.

The Director of Civilian Marksmanship

AT the head of all activities which seek to promote the art of straight shooting stands the National Board for the Promotion of Rifle Practice. This organization, officially attached to the War Department, was organized under Act of Congress, July 30, 1904. The president of the board is the Assistant Secretary of War, Hon. Dwight F. Davis, and its members are representatives of the Army, Navy, Marine Corps, National Guard, and the National Rifle Association of America.

The board is charged with the duty of considering all questions touching upon the promotion of efficiency with small arms, and of making recommendations to the Secretary of War looking to the encouragement of marksmanship in the services, and among the citizens.

The office of the Director of Civilian Marksmanship is one of the principal agencies in carrying out the recommendations of the National Board for the promotion of Rifle Practice insofar as they concern the citizen marksman. Existing regulations place within the reach of citizens of the United States, arms, ammunition, target material, and range equipment for the purpose of encouraging the general public to regard and indulge in rifle shooting as a sport.

Under existing laws, certain appropriations have been made available for the purchase of ordnance stores for issue and sale to civilians, in furtherance of the government's policy of encouraging marksmanship. The issue and sale of these stores are handled exclusively by the Director of Civilian Marksmanship, as well as the issuance of rifles and ammunition to schools that have established a course in military training. He also makes arrangements for the use of government rifle ranges by rifle clubs, and issues the army insignia to civilians who qualify with the rifle and pistol. During the last fiscal year over 10,000 rifle and pistol qualification badges have been issued to civilian riflemen. The sales of arms, ammunition and equipment to civilians in the past year totaled more than a half million dollars, while the ammunition issued free to riflemen in a year, exceeds the total amount expended a decade ago by the services, National guards and civilians combined.

The present director is Colonel George C. Shaw, who took charge of the office on August 20, 1924. He has taken an active interest in rifle and pistol shooting for more than 25 years, and his policy is to accord the greatest possible assistance to civilian riflemen, not only in providing the authorized equipment, but in securing special equipment and in furnishing advice with reference to arms, ammunition, ranges, and other subjects connected with rifle and pistol shooting.

Improved Quality Steel Production

By

EMIL GATHMANN

THIS paper sets forth fundamentals essential to quality steel production and certain improved ingot molds and appliances whereby tonnage production of sound steel has been made possible and practicable.

Prior to the Government's insistence upon a literal fulfillment of its exacting specifications for quality in vast tonnage of material, the user of so-called commercial quality mill and forging steel, with few exceptions, accepted (with frequent complaints, it is true) many defects, which were known to be inherent in the usual type of pyramidal big-end-down ingots. When interior defects developed and the piece broke during the process of manufacture or during the use of the finished product, the forger or steel treater was usually held responsible, and at most, the steel maker replaced the specific bar, billet or bloom from which the condemned product had been made.

As early as 1912 and 1913 the writer and many other engineers and metallurgists called the attention of quality steel makers to the fact that an unsound ingot could not by any amount of work be made into a sound or homogeneous product. Little interest was, however, given by the commercial steel maker to this fundamental requirement of sound ingots until the Army Ordnance and Navy Departments insisted upon their interpretation of the term of "soundness." Today commercial users of quality steel likewise insist upon and obtain real soundness in steel product used in their arts.

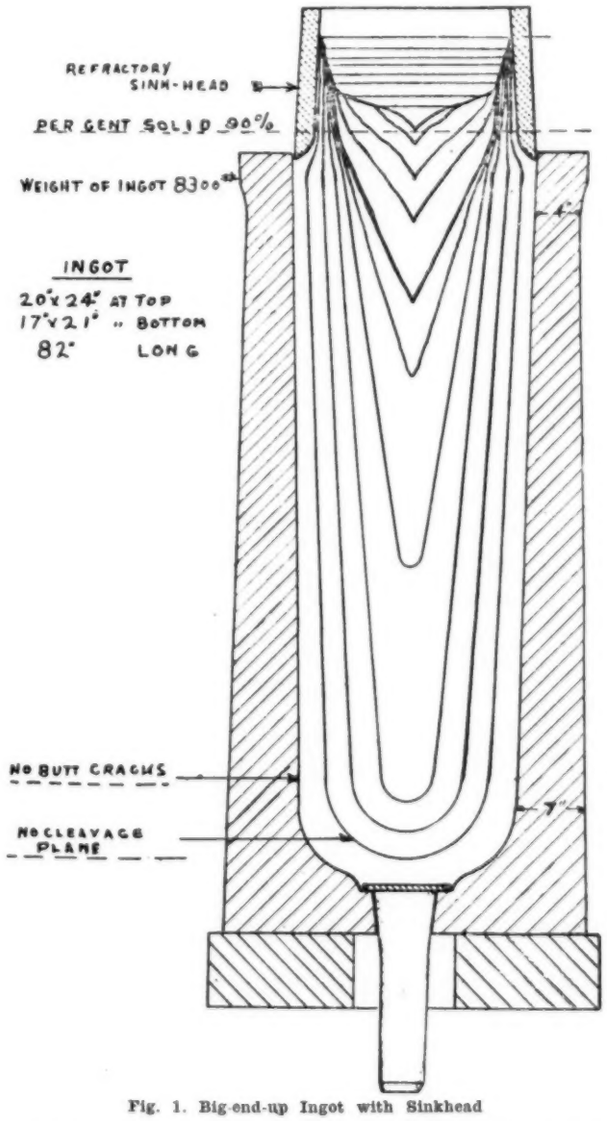


Fig. 1. Big-end-up Ingot with Sinkhead

Characteristics: Perfect feeding, cokey centers impossible, pipe in small percentage at top only, secondary pipe impossible, segregation only in sinkhead (top crop) butt cracks, no cleavage plane, no flaws, average percentage sound steel: 83 to 90

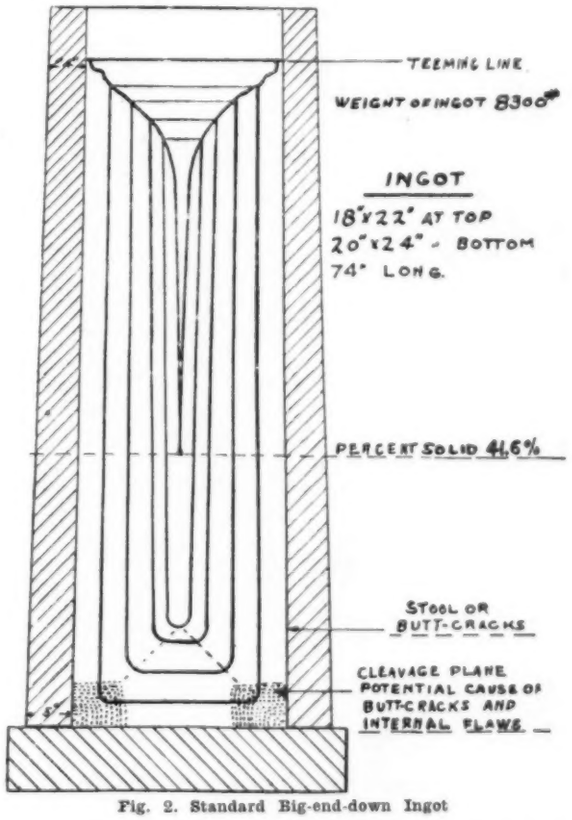


Fig. 2. Standard Big-end-down Ingot

Characteristics: Feeding impossible, cokey centers probable in half of ingot, pipe in high percentage inevitable, flaws at cleavage plane frequent, butt cracks common, average percentage sound steel: 55

It is the author's confirmed belief, reinforced by the opinions and practice of many leading engineers, metallurgists and quality steel makers that one of the fundamentals in commercial quality steel production is the use of the big-end-up or inverted pyramidal ingot in combination with other fundamental practice as described in detail in this paper.

Steel deoxidized as well as may be, which is or should be the basis of most quality steel products solidifies by what has been termed by the late Dr. Henry Marion Howe "The pinetree or land-locking type of crystallization," there being no gasses evolved due to chemical reaction and a minimum of gases in solution during solidification of the ingot.

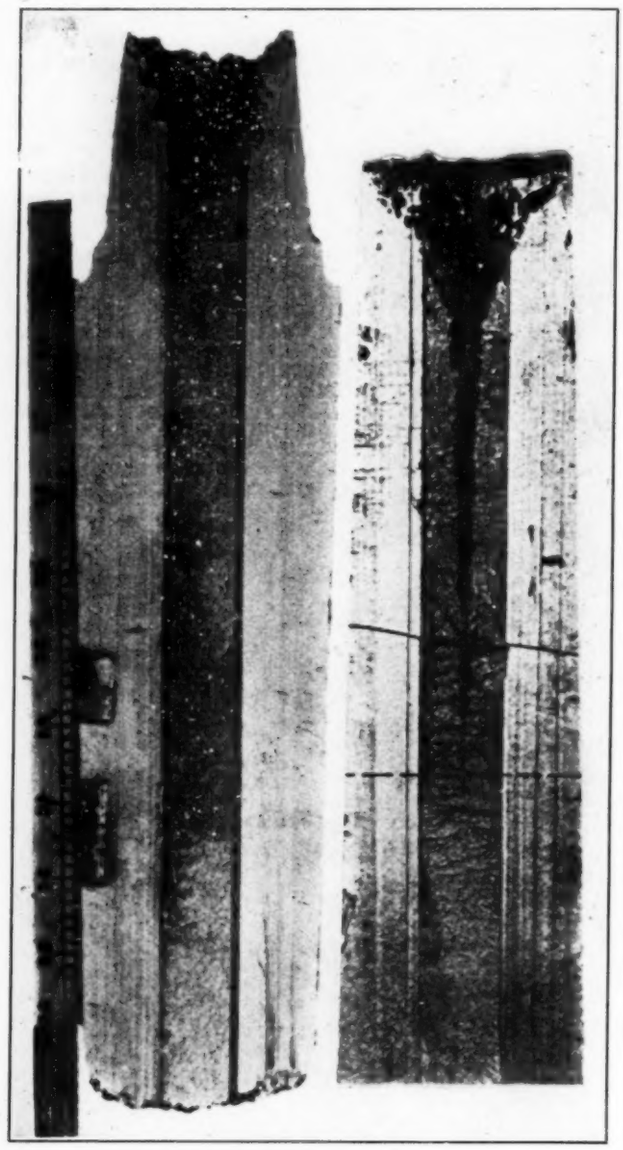


Fig. 3. Comparison of Ingots

Left: Large ingot made in big-end-up mold with refractory top and layer of graphite top insulation. Right: Standard big-end-down ingot without sinkhead but of similar body size

This mass of liquid steel lies quietly and crystals form, grow and extend into the mother liquid or molten interior of the ingot from its initially solidified outer portion or ingot skin, until finally the crystals have formed a solid interlocking mass, thus building the structure of ingots of this type, without so-called blow holes; but leaving a void or so-called pipe, due to volumetric shrinkage, extending downwardly from the upper portion of the ingot. The depth, but not the volume, of this pipe or shrinkage cavity, depends upon the type of mold and method of teeming and cooling of the ingot.

Figs. 1 and 2 show the freezing or formation of ingots of well-deoxidized steel. The big-end-up and big-end-down molds of same size cross-section have illustrated thereon by means of lines the contours of freezing or successive ingot skin thicknesses, illustrating the method of solidification and type of shrinkage cavity produced in ingots made by these two types of molds.

It is essential in order to prevent a deep-seated pipe in the solidified ingot that the growth of the pinetree crystals should be induced or accelerated from the bottom of the ingot upwardly; this in order that a continuous body of liquid steel may obtain automatically towards the upper portion of the ingot and thus reduce the depth of the shrinkage cavity or pipe due to the decrease in the volume of steel within the original skin or envelope initially solidified by contact with the walls of the mold cavity. The best and most economic results in the formation of this type of casting are obtained by employing the big-end-up mold and in so shaping the ingot that it will have a continuously increased volume of horizontal cross-section from the bottom of the ingot upwardly and in forming the uppermost portion of the ingot within a suitable refractory heat-insulating sinkhead or mold top to carry the final reservoir of molten steel for feeding the portions of the ingot located below the said refractory top portion of the metallic mold.

The diagrammatic structure of the ingot shown in the big-end-up and big-end-down molds has been proved to be correct by many tests conducted at various steel plants and is today accepted as part of the proven art by almost all makers and users of quality steel.

In order to obtain an open pipe, i. e., prevent the formation of a frozen ceiling or bridge covering the sinkhead cavity, it is necessary to cover the entire top of the molten steel immediately after the ingot is poured with a material of high heat-insulating quality, such as infusorial earth, flake graphite, or similar substances. The pipe or shrinkage cavity will then remain entirely open and the entire process of the formation of the pipe may be readily observed.

In actual commercial practice, we do not recommend the production of a pipe of this character and prefer to allow the top of the ingot to solidify before placing thereon any heat-insulating medium.

Graphite or any other carbonaceous material naturally should not be employed as a top covering for any ingot, except for experimental purposes to demonstrate the formation of pipes in thoroughly deoxidized steel.

As excessive taper of an ingot is usually objectionable both for mill and forge practice, we have found that a considerable decrease in taper is permissible without changing the character of the shrinkage cavity desired, if the mold walls are made relatively more heat-absorptive for the lower section of ingot than for the upper portion.

The shrinkage cavities in the standard big-end-down and Gathmann big-end-up ingots as shown are a fair average from many tests made. The actual lines of solidifica-

tion as shown in the figures taken from data as far as such are available in the literature of the art, aided by many experiments of our own. Such lines as we have not had experiments to work from, have been placed by interpolation between lines which have been arrived at by actual experiment.

At the left in Fig. 3 is shown a large ingot made in our big-end-up mold with refractory top and a layer of graphite top insulation placed on the liquid steel. This photograph illustrates the big-end-up ingot.

At the right in Fig. 3 is a standard big-end-down ingot, no sinkhead, but of similar body size.

In the making of sound quality steel there are certain fundamental requirements which have been generally accepted by those steel makers who are at the present time leading and showing the way to further improvements in the production of the product.

Preparation of the Molten

The first requirement is obviously in the preparation of the molten. It is advisable that the steel in the bath, be it Bessemer, Open Hearth, Electric Furnace or Crucible, should be melted from stock with the assurance that a minimum of deleterious matter be introduced.

The second requirement is that proper finishing, i. e., deoxidation and cleansing, of the bath at suitable temperature be obtained before tapping of the heat, the degree and character of said finishing and deoxidation being dependent upon the character, grade and quality of the final product required. The third requirement is that some deoxidation or finishing in the ladle is essential, especially for the higher grades and qualities of steel, but this finishing in the ladle should be held to a minimum and should be confined to such as cannot be done previously without undue expense or administrative difficulties.

Teeming of the Molds

There is always a certain volumetric shrinkage of steel of any specification in going from the molten to the solid, which volume of shrinkage is dependent on the factors of temperature of the molten, chemical composition of the heat and the volume of gases present in the steel at the time of teeming, i. e., the hotter the molten, the greater the difference in the reduction of volume to the solid. It is advisable that the pouring temperature or that at which the steel is teemed into the molds should be no higher for top casting than necessary to obtain a clean teeming stream. To regulate the time of pouring, a suitable size of ladle nozzle should be used, the specific cross-section of the nozzle varying with the character, grade and quality of steel and with the cross-section and weight of the ingot being teemed.

Solidification of the Molten Steel in the Mold

The ingot solidifies in the mold by crystallization, which starts at right angles to the ingot's exterior surface, both sides and bottom. If this surface is in contact with mold chamber walls of a plain rectangular contour, either at the base or sides, it follows that the axes of dendritic crystallization are mostly parallel lines resulting in the formation, where these axes intersect due to corners, of cleavage planes injurious to the strength of the ingot. These cleavage planes are more pronounced in well-deoxidized than in ingots produced from a gassy or boiling molten. It has long been well-known that if the vertical surface of the ingot is suitably corrugated or fluted, the axes of crystallization are crossed and interwoven and hence eliminate, or at least greatly reduce, these planes of cleavage and give a stronger ingot structure.

Contact of Ingot with Mold Walls

The ingot should be free at all times to shrink during solidification and formation of the ingot structure in any and all directions within the mold chamber and consequently the chamber should be so designed as to prevent any mechanical binding or tying of the ingot to the mold walls. The contour of the mold chamber, both vertically and horizontally, should thus be so shaped as to allow of free and unimpeded shrinkage of the ingot and the walls should be clean and free of foreign matter.

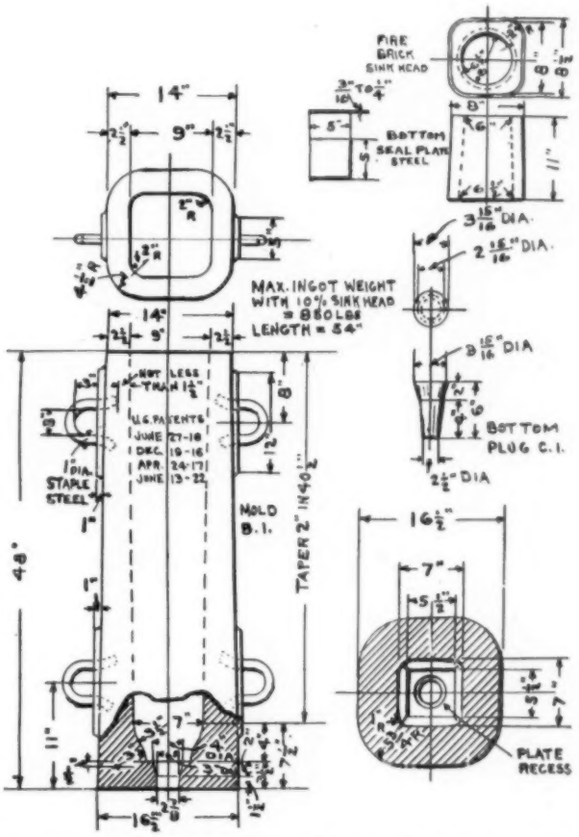


Fig. 4. Typical Big-end-up Gathmann Mold for Floor or Pit Practice

As the ingot solidifies progressively from its outer portion initially in contact with the mold chamber walls, the walls in good practice should be so constructed that they will firmly support this outer solidified surface of the ingot for a brief period of time, or until the initial walls, or skin, have become sufficiently thick and firm to resist liquid pressure of the molten mass forming the interior of the ingot. The mold walls should, therefore, be relatively heavy as compared to the section of the ingot. The sound quality steel ingot should not be stripped from the mold or the mold from the ingot until the ingot has become substantially solidified throughout its entire volume. In high carbon and alloy steel this time interval is considerably greater than in low carbon or open steel.

The ingot should be charged hot in the soaking pit or reheating furnace as soon as practicable after stripping from the mold whenever this is possible and allowed to soak or equalize in temperature before reheating to suitable rolling or forging temperature.

Reduction of the Ingot

It should always be remembered that the ingot irrespective of its physical or chemical analysis, when taken from the soaking pit or heating furnace is merely a heated steel casting (a chill casting at that) and, until work is done upon its surfaces, has inevitably the weakness inherent in castings as compared with forgings. The work, therefore, must be so performed that no unworked surface receives material deformation before it itself is worked. In rolling mills, this is accomplished by making the initial passes light and by frequently turning the ingot, the extent to which this rule can be followed being governed by business considerations.

These fundamentals have been commercially applied by our Company in consulting work with many steel companies using our big-end-up molds, in which over a million tons of ingots have been cast during the past year.

The Big-End-Up Mold

Fig. 4 shows design of a typical big-end-up Gathmann type ingot mold for floor or pit practice. This type of mold is in extensive use in production of ingots having a cross-section of from 6 by 6 inches to 16 by 16 inches and weighs from 350 pounds to 3600 pounds per ingot.

Note carefully that the ingot mold shown has a cavity 7 inches square at its lower end and 9 inches square at the upper end; also that the lower mold wall is 4¾ inches thick, while at its upper end it is only 2½ inches thick. These ingot dimensions and mold wall thicknesses give what we call a freezing ratio for this mold of approximately 6 to 1, or in other words, the mold per cubic inch of ingot considered absorbs heat six times more rapidly at its lower end than at its upper end, with intermediate values of heat absorption between these points. This large freezing ratio is necessary for ingots with a high ratio of length to diameter.

Note further that the lower end of the ingot is necked in and formed by a compound curve ending in a flat bottom or plate recess, thus effectively preventing cleavage cones and butt cracks. The bottom of the mold is closed by a conical closing and stripping plug, the lower portion of which projects below the mold bottom to be used as an ingot ejector when necessary. Above the plug and fitting closely in the chamber bottom, which we term a plate recess, is placed a thin steel plate, the function of which is to protect the bottom of the mold chamber against erosive wear and prevent the sticking of plug to ingot, the plate itself being welded or stuck fast to the bottom of the ingot and cropped therewith.

The sinkhead or refractory top shown is designed to be placed on the molten steel as soon as the mold is filled to its desired height and then itself poured full, this method of hot-topping being the standard old dozzle practice of crucible steel makers for many years and its use is advised by us mainly for small-sized ingots, its advantage being that part of the shrinkage of the ingot takes place before the sinkhead is filled.

It is difficult in large ingots to perform the timing operation correctly and in these we prefer a sinkhead placed on top of the mold and through which the steel is poured for the entire ingot. The hot top for all molds should be so constructed or equipped that hanging of the ingot in the top will not occur as this hanging is apt to impede free shrinkage of the solidifying ingot structure.

In stripping, the ingot may be either caught by its sinkhead with suitable tongs and lifted out or the mold may be upset and the ingot dumped, whichever method is most suitable to the individual plant.

The yield of sound quality steel obtainable from ingots of this type and size is dependent mainly on the segregation range permissible within the ingot and the workmanship or skill with which the various operations are carried out.

For ingots from 6 to 12 inches square there is little carbon segregation, the solidification taking place so rapidly that the dendrites entangle the segregates before they have a chance to emigrate and cool in clots. This yield in actual practice is somewhere between 85 and 90 per cent of the ingot weight for the sizes of ingots mentioned. For larger ingots and up to 34 inches square weighing 20,000 pounds, the yields are dependent on these same factors, in addition to which the type and heat efficiency of the sinkhead largely enter. The yields obtainable here range from 80 to 85 per cent of the ingot weight, being less as the size and weight of the ingot increases.

The desirability of all products being made as sound as the state of the art permits is unquestionable. There are, however, many practicable and commercial problems involved in tonnage steel production, and at the present state of the art it costs the steel maker from three to ten dollars additional per ton of product to produce reliable, homogeneous steel in the bloom, billet or bar, without, however, necessitating any reduction in the tonnage output.

The insuring of better surface conditions of the steel ingot and its products by employing molds of suitable chamber contour does not, however, involve any added expense in either high grade or so-called commercial tonnage specifications.

The new type of different corner cross-section of ingot is thus economical for all steel products that have as their genesis a mill ingot of whatever grade or quality of steel.

In this paper I have merely attempted to state a few facts and set forth the things that I consider most important. It is my belief that we are just at the beginning of our knowledge of this most important art. The aim of this paper is to make available for those whose work is in the application of such principles to industry this improved practice in quality steel production so that they may thereby be better able to produce steels more economically and of quality more reliable under the severe tests to which they may be, and in some cases must be, put by their users.

Italian Tanks

By

FRITZ HEIGL

VERY soon after the first authentic accounts about the appearance, effect and construction of tanks had come from the western theater of war, the Italian General Staff began to focus attention upon this new weapon. The General Staff, it appeared, had no intention of bringing into use large fleets of tanks on their theaters of war which were not any too well suited for the operation of tanks; on the contrary, both the General Staff and the line, but chiefly the domestic manufacturers, wished to make themselves thoroughly familiar with this new means of fighting in order later to be able to equip a tank corps with first-class types.

With this intention, the Italians requested and obtained from the French in the latter part of the War, and following the War—inasmuch as their own types had already been decided upon—a Schneider tank and a few light tanks, which grouped together with single Italian vehicles were tested at several places, such as at the Infantry Central School at Civitaveccia, and thus furnished useful practical knowledge to the General Staff and the line.

Even today, therefore, we will find the French light tank in a few cases in the Italian army.

Much more interesting and important, nevertheless, is the tank which the Italians have created by their own effort, and from a constructive standpoint, we must not here deny them the recognition that is their due.

The Italian tank troops *"Reparto Carri Armati,"* as they stand today, just since the last few years, are stationed in Rome and are under the command of Colonel Noe Grassi. They cannot be said to have very great strength and probably at the present time have scarcely more than a few heavy tanks and hardly more than the original order of 100 light tanks, both the product of the Fiat Company in Turin.

This weakness in numbers is explained by the tendency of the Italian General Staff in that they do not know the tank well enough and mistrust the suitability of their own theaters of war with respect to the possibility of the utilization of tanks. In the east, the "Karst," in the west the French Alps, in the north the Austrian and Swiss Alps hinder the effective development of strong tank military forces, so that the tactical theory endures:

"We can make use of tanks only on this side or on the farther side of the Alps."

This mistrust in the practicability of the utilization of tanks explains the oft-spoken tendency to organize the *"Reparto Carri Armati"* only as the nucleus of a large tank corps to be mobilized in time of war, not only for the purpose of making the troops familiar with tanks and instructing specific tank drivers and forces, but also for the purpose of gathering practical knowledge in construction, in order that they may be able to manufacture in quantity production the most approved types in future emergency. In fact, the Italians, as already pointed out, hold to their two types, the heavy "Fiat Type 2000" tank, and the light "Fiat Type 3000" tank not only in regard to the choice of types; two vehicles agreeing with modern views, but even these must also be very carefully specified.

The Heavy Fiat Type 2000

The 40-ton heavy tank, which is shown in Figures 1 and 2 and in the sectional view of Fig. 3, is in many respects worthy of note. Among other things, it is said, according to French accounts, to have been developed very early. The studies are said to have been begun in August, 1915, by order of the government. If this is so, the Italians began the construction of tanks earlier than the French; it is certain, nevertheless, that the heavy tank originated without any prototype whatever. From the same source, the inauguration of manufacture took place in October, 1916, and a first test in June, 1917. On the Italian side, on the contrary, it is reported that the tank originated in the second half of the War, about 1917, and so long as no authentic accounts of the firm of Fiat or of the Army are at hand, this statement seems

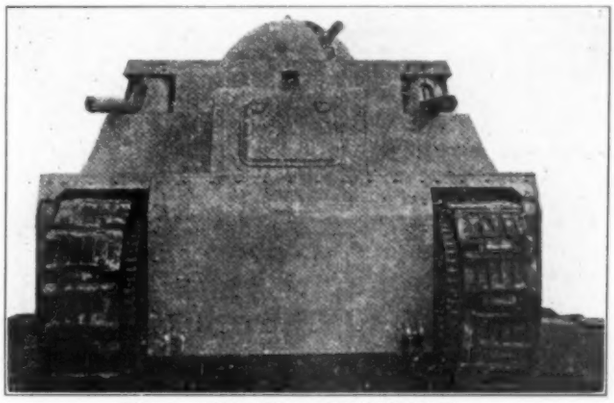


Fig. 1. "Fiat Type 2000," front view

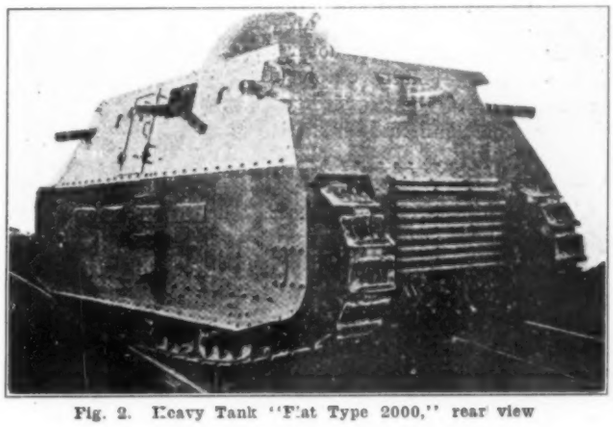


Fig. 2. Heavy Tank "Fiat Type 2000," rear view

the more plausible. It is certain that at the time of the Armistice two models of the "Fiat Type 2000" tank were in existence, of which one was later sent to Tripoli, while the other remained in Rome. At the present, as already mentioned, several models of heavy tanks seem to be in existence.

The weight of 40 tons of the heavy tank is large considering the time of its origin. It is very heavily armored: 20-mm. in front, at the back and at the sides, 15-mm. above. It is also heavily armed: a 65-cm. gun (21, mountain gun) in the turret (22) and seven machine guns (Fiat-Revelli), of which four are in the four corners, two in the middle of the side walls, and one in the middle (19) of the back. Two machine guns can therefore be fired directly towards the front, but three directly towards the rear; an appoach on this tank from the rear is thus prevented.

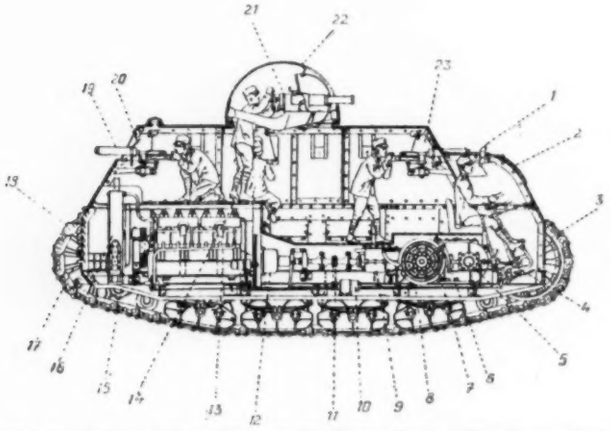


Fig. 3. Sectional View Through the Heavy Tank "Fiat Type 2000"

The armament requires a crew of ten men. The machinery layout is under the fighting compartment, distributed in such manner that the 240 h. p. 6-cylinder motor (13), a special airplane motor of 1200 r. p. m., is placed in the rear and directly in line with and in front of the radiator (16) and the fan (15). The air openings for the radiator are cut in the vertical armor at the rear (17). The motor drives a gear transmission (9) through a main clutch (12), whence the power is transmitted to the transverse axle, on which, as in the Renault or Schneider tank, the discs of the steering clutch (8) are fitted. The casings of both steering clutches are fitted to the brake drums, on which the steering brakes (outer side-brakes, 7) grip. The steering is accomplished, therefore, as usual, by cutting off the power from the inner track through cutting out the corresponding steering clutch and at the same time braking the track by means of the side brakes.

Through a transmission gear (6) each steering clutch drives a sprocket on the cross-shaft (5), which transmits the power to the driving wheels (3) by means of large *"Gallsche"* chains. The driving wheels, therefore, are in front in a peculiar manner, which must be shown as a disadvantage, and which is accompanied by the evident tactical disadvantage of the vulnerability of the visible *"Gallsche"* chains (see Fig. 1), which are susceptible to even normal gun and machine gun fire.

The sectional view in Fig 3 shows the driver sitting behind the armored hood (2); he looks through a periscope (1). In front of him in the armor plate is a large airhole which may be closed by means of a cover also of armorplate. The exterior of the vehicle must be considered as very advantageously designed, above all for the form and protection of the tracks. Nevertheless the height dimensions in particular have become rather great. Wherever possible inclined surfaces are used. The tracks which are arranged to move forward and backward make possible an unhesitating ability to climb and to cross trenches. They are well sprung by means of swinging bogies, four in number, so that each track runs on ten supporting rollers, including the outer unsprung rollers.

The tank is large: its overall length is 7.40 m., its width 3.10 m., and its height 3.80 m. The width of the tracks is, however, narrow, 45 cm., which must lead to a high, even disadvantageous, unit ground pressure. Its ability to cross trenches must amount to at least 3 meters span. Its ability to climb is also good—it is able to negotiate grades of 35 or 40 degrees; it should be able to surmount obstacles of 1 meter in height. Its speed is given at 7.5 km. per hour, maximum; at any rate it amounts to practically 6 km. per hour under favorable circumstances. Altogether it is a practical and interesting construction which reflects credit on the Italian manufacturers. The heavy armor and armament, augmented by a speed, give it a considerable fighting value, so that it fulfills its tactical problem as a heavy (destroying) tank.

Nevertheless it appears to us that to the light tank should be given the greatest stress today.

The Light Fiat Type 3000

The French *"Char leger"* (light tank), mentioned above, will be described more at length in another article. On this French type the light Fiat Type 3000 tank, of which, as mentioned, 100 were ordered in April 1919, was modeled, taking advantage of all possible improvements.

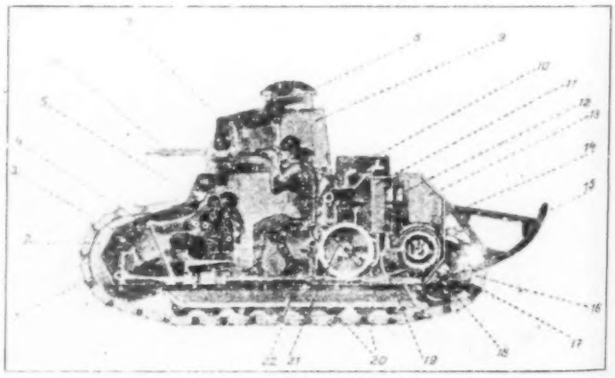


Fig. 4. Sectional View Through the Light Tank "Fiat Type 3000"

Manufacture was begun in June, 1919, and the first test took place in August, 1920. Experiments were again resumed in November, 1921; its first practical use was early in the year 1923 at Belluno. We may therefore draw the conclusion that this material is probably still considered as part of their equipment.

This tank, a sectional view of which is shown in Fig. 4, is somewhat similar to the *"Char leger,"* but smaller; its overall length, including the tail-piece (75) is 4.2 m., its width 1.65 m., its height 2.2 m. The Italian tank may be recognized by its somewhat differently shaped turret, but especially by its smaller and lower engine

room at the rear. A notable difference lies also in the tracks; these extend far out to the rear and are propelled also at that point. Like the French tank, the Fiat Type 3000 has also a detachable tail-piece at the rear, which enables it to take trenches 1.80 m. in width. Its maneuvering ability is good; its speed is at the present time the highest of all tanks developed on the European continent; it attains practically 15 km. per hour maximum, and under particularly favorable conditions can be increased to 20, even 22 km. per hour. This great speed is attributed principally to its light weight—the tank weighs only 5 tons—and to its very powerful motor, as also to the advantageous efficiency of the mechanism. The motor (21), a 4-cylinder special motor of 1700 r. p. m., is of 54 h. p., as against 35-39 h. p. for the *"Char leger."* It should give to this tank also a considerable climbing ability, which cannot be less than that of the French tank, viz. 51°.

Its fording ability is considerable and amounts to 1 m. depth of water; similarly it can, on account of its more powerful motor, fell larger trees than can the *"Char leger,"* namely, trees of 25-30 cm. in diameter, also brick walls of 40 cm. in thickness.

Its tactical value is therefore very great which is sustained by the fact that it is well protected by armor 16-17 mm. in thickness practically throughout, with 8 mm. armor for the deck.

Its armament today consists exclusively of two duplex-mounted "S. I. A." machine guns (6) with 2,000 rounds (a new light machine gun developed since the Armistice, with a magazine capacity of 50 rounds, 750 shots, and 3,000 m. range); but the Testing Board urgently requested a partial arming with cannon, so that in future at least some might also carry 37-mm. cannon, as the French tanks.

Also of interest is the recommendation of the Testing Board that a winch be built in the tank, to enable it to pull itself up steep grades.

The machinery layout varies as to construction quite materially from that of the *"Char leger"*; it is simplified and improved, and therefore lighter, and works with favorable efficiency. The motor (21) lies crosswise and forward in the engine room, as also the fan (12) and the radiator (11); the motor through a gear transmission (12) drives a differential, both of whose axleshafts carry brake-drums (18) and on their outer ends the power gears for the driving sprockets. The driver, therefore, steers the vehicle somewhat differently than is customary in most tanks, by braking the differential by means of the side brakes (18-19) which grip on the brake-drums, without thereby cutting out the power on that track. This simple method of steering is being employed on most light tractors coming into commercial use. Noteworthy also is the abolition of the manifold gearing necessary in the *"Char leger"*; the gears work directly on the driving wheels (17).

The remainder of the exterior and the fighting compartment are modeled on the *"Char leger."* The driver sits forward on a narrow cushion, watches through the forward and two side openings (at 5), has his hands for the most part on the steering levers (4) and his feet on the pedals (1) in the coffinlike prow of the tank (3). His back rests against a folding back-rest, as in the *"Char leger."* Just as in the Renault tank, here also the gunner and commander of the vehicle sits in a sling-seat, which is suspended from the turret. The turret moves on ball bearings. It has doors (9) at the back and a mushroomlike cap at the top for ventilation and also for observation. 7 shows the magazine chests for the machine gun. The fighting compartment is separated from the engineroom by a bulkhead, in order to confine the direct hits when possible to one room and to stop the spread of a fire. The gasoline tank in this model also is under the roof, but farther to the rear (13).

Below is given a table showing the characteristics of the three types of tanks under discussion:

Type	Fiat 2000	Fiat 3000	Char leger
Studies Begun	1917	July, 1918	Taken over from the French
Delivery	1917-18	Aug 1920 & following year	1918-1919
Number Made	5-10	About 100	5-10
Weight in Tons (metric)	40	5	6.5 - 6.7
Overall Dimensions (meters)—			
Length	7.4	4.2 overall	5 overall
Width	3.1	1.65	1.74
Height	3.8	2.2	2.14
Ground Clearance (meters)	0.54	0.35	0.4
Track Width	45 cm	28 cm.	34 cm.
Armor Thickness in mm.—			
Front	20	16	16 & 8
Side	20	16	16
Rear	20	16	8
Deck	15 turret 20	8	6.5
Speed (per hour)	1 km.	2 km.	1.5 km.
Max. Speed (per hour)	7.5 km.	15 km. possible 20-22 km.	7.8 km.
Armament	1.65 mm. cannon 7 M. G.	2 duplex-mounted "S. I. A." M. G.	1 M. G. or 1 37-mm. cannon
Crew	10	2	2
Engine Horsepower	240	54	39
R. P. M.	1200	1700	1000-1500
Type of Engine	Fiat 6 cyl. special mo.	Fiat 4 cyl. special mo.	Renault 4 cyl.
Gasoline Capacity (liters)	600	90	90
Radius of Action	75 km.	180 km.	45-60 km.
Bridging Ability	3-3.5 m.	1.8 m.	1.8-2.2 m
Max. Height of Obstacle	0.9-1 m.	0.6 m.	0.6 m.
Climbing Angle	35-40°	45-50°	45° forward 51° backward
Fording Ability	1 m.	1 m.	0.7 m.
Destroying Ability	Trees of 50 cm. dia.	Trees of 25-30 cm. dia.	Trees of 20-25 cm. dia.

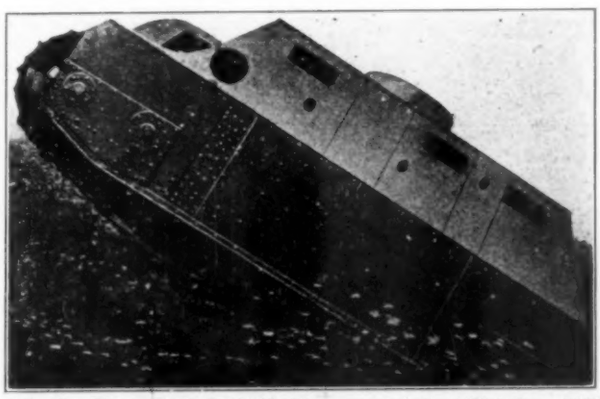


Fig. 5. Heavy Tank, Probable Forerunner of the "Fiat Type 2000"

In Fig. 5 a heavy tank is to be seen which, instead of the revolving turret has a fixed armored tower and in which the armament has not yet been installed. Quite similar in construction to the Type 2000, it shows, nevertheless, differences in the armorplating. Probably it is the experimental model and the forerunner of the Type 2000, to which it is inferior in design.

Ed. Note: This article is a translation from Militärwissen-Schaftliche und Technische Mitteilungen, Sept.-Oct., 1924, by permission of the author.

American Chemical Society at Aberdeen

Chemists Impressed by Recent

Members of American Chemical Society at Aberdeen Proving

OVER a thousand members of the American Chemical Society in attendance at their annual spring meeting at Baltimore, April 6th to April 10th, journeyed to Aberdeen Proving Ground Thursday, April 9th, as guests of the Army Ordnance Department, to witness recent chemical and explosive developments in ordnance. All were highly impressed with the remarkable strides made by the Department since the World War, and many expressed wonder at the tremendous accomplishments in the development of high explosives and other chemicals which the Department has brought forward.

Like a great many others in the various professions and industries of the country, not all chemists are thoroughly cognizant of the important relationship of chemistry to the ever-changing demands of ordnance.

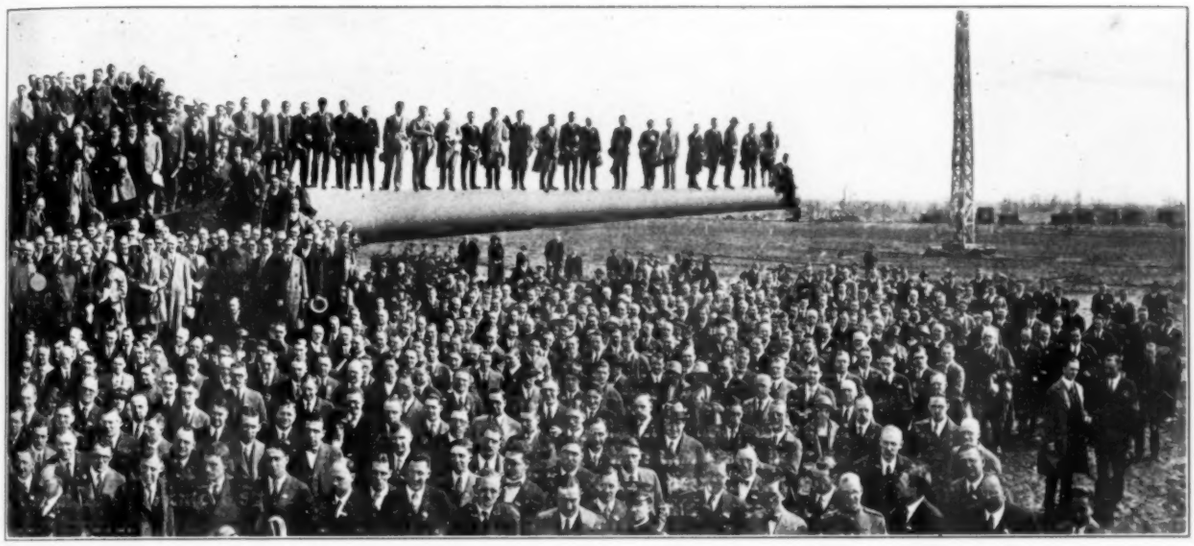
The members of the Society who attended the Baltimore convention, which, by the way, was one of the most significant and constructive ever held by that organization, made two side excursions during their program of activities. On Wednesday, April 8th, the members journeyed to the U. S. Naval Academy, where they were shown the methods of training midshipmen and the facilities for carrying on this work, and on Thursday, April 9th, they made the trip to Aberdeen to acquaint themselves with the work of the Ordnance Department.

Leaving Baltimore at 1 p. m., the visitors arrived at the Proving Ground shortly after 2 o'clock and were presented with a program of activities which has rarely been equalled by the authorities at the Proving Ground except possibly at the annual demonstrations at the meetings of the Army Ordnance Association. Boarding the Proving Ground train, the chemists were taken to Mulberry Point where demonstrations of the larger caliber matériel were given. Firings were conducted with the 16-inch gun on Barbette carriage, the 14-inch gun on railway mount, and other similar caliber pieces. These firings were of special interest to the chemists, in view of the importance of the powder development and manufacture, which is a most important essential in the development of the larger seacoast guns. In the case of the 16-inch gun, which is the largest ever constructed for seacoast defense in America, the maximum range is over 31 miles with a projectile weighing 2,340 pounds; the charge weighs 850 pounds. Likewise, in the case of the 14-inch gun on railway mount, Model 1920, which is also the largest railway mount designed for seacoast defense, the maximum range is about 22½ miles with a projectile

Automotive Exhibition for American Chemical Society

Witnesses Demonstration Proving Ground

Explosives Developments in Ordnance



Ground April 9th, 1925, as Guests of Army Ordnance Department

weighing 1,560 pounds, the powder charge weighs 470 pounds.

After witnessing these firings, the chemists were taken to the aviation field where aircraft was demonstrated. This included maneuverings of the *TC-2*, one of the larger dirigible airships used by the Army, and a spectacular element was introduced by parachute jumping by two of the personnel attached to the Proving Ground.

The next feature was conducted at the main front where a detailed examination of trucks, tractors, etc., followed. Various automotive matériel was also demonstrated. Here, again, considerable interest was shown in developments of this class of ordnance and some enthusiastic members of the visiting chemists were given rides in tanks and on tractors.

Probably one of the most spectacular events of the day was a group of firings from anti-aircraft guns using the newly developed Chelsea mechanical time fuzes.

Due to the fact that the visitors were required to leave the Proving Ground at 5 p. m. to fulfill other program arrangements of their convention in Baltimore, it was impossible to demonstrate to them some of the latest developments in small arms ammunition, notably the firing of tracer bullets, as well as the demonstration of flashless powder.

From the enthusiastic reports received after the visitors left the Proving Ground it may be said that this demonstration was one of the most important thus far conducted at the Proving Ground in that it demonstrated to one of the largest scientific bodies of the country the great developments that have been made in the manufacture of powder and explosives by the Ordnance Department, and, too, in that it demonstrated to the chemists of America the need of full co-operation with the Department in carrying on its chemical research.

The visitors were welcomed to the Proving Ground by Col. Wm. H. Tschappat, Commanding Officer, who extended to them all the courtesies of the post. Maj. Gen. C. C. Williams, Chief of Ordnance, was represented by one of his assistants, Brig. Gen. John W. Joyes, Chief of the Technical Staff of the Ordnance Department.

This visit of the American chemists, therefore, was most auspicious in that it demonstrated to them the important work being done by the Ordnance Department in the development and manufacture of high explosives and other chemicals: an important function in peace and a tremendous responsibility in war.

Chemists Display Great Interest in Firings of Browning Machine Guns

Carburization as a Factor in the Erosion of Machine Gun Barrels*

By

W. W. DE SVESHNIKOFF

THE combustion of the charge during firing of a machine gun creates an extremely high temperature (about 2800° C.) with a pressure of about 51,000 pounds per sq. in. (in the breech end). The final products of combustion of powder are gases,[1] such as CO_2, CO, N_2, CH_4, H_2, H_2O. The effect of the high temperature and pressure is greatest near the breech end of the barrel. The temperature of the bore surface rises rapidly with an increased number of rounds fired. As part of a special investigation of gun erosion, machine gun barrels made from special steels were fired for 11,000 rounds at a rate of 250 shots per minute and the results reported here were obtained in this investigation.

The firing produced a structural change in the skin of the bore. The greatest change took place at about .60-inch

*Ed. Note: This paper is published by permission of the Director of he Bureau of Standards of the U. S. Department of Commerce and of the Chief of Ordnance, War Department.

1A. Marshall, Explosives, Vol. I, p. 319.

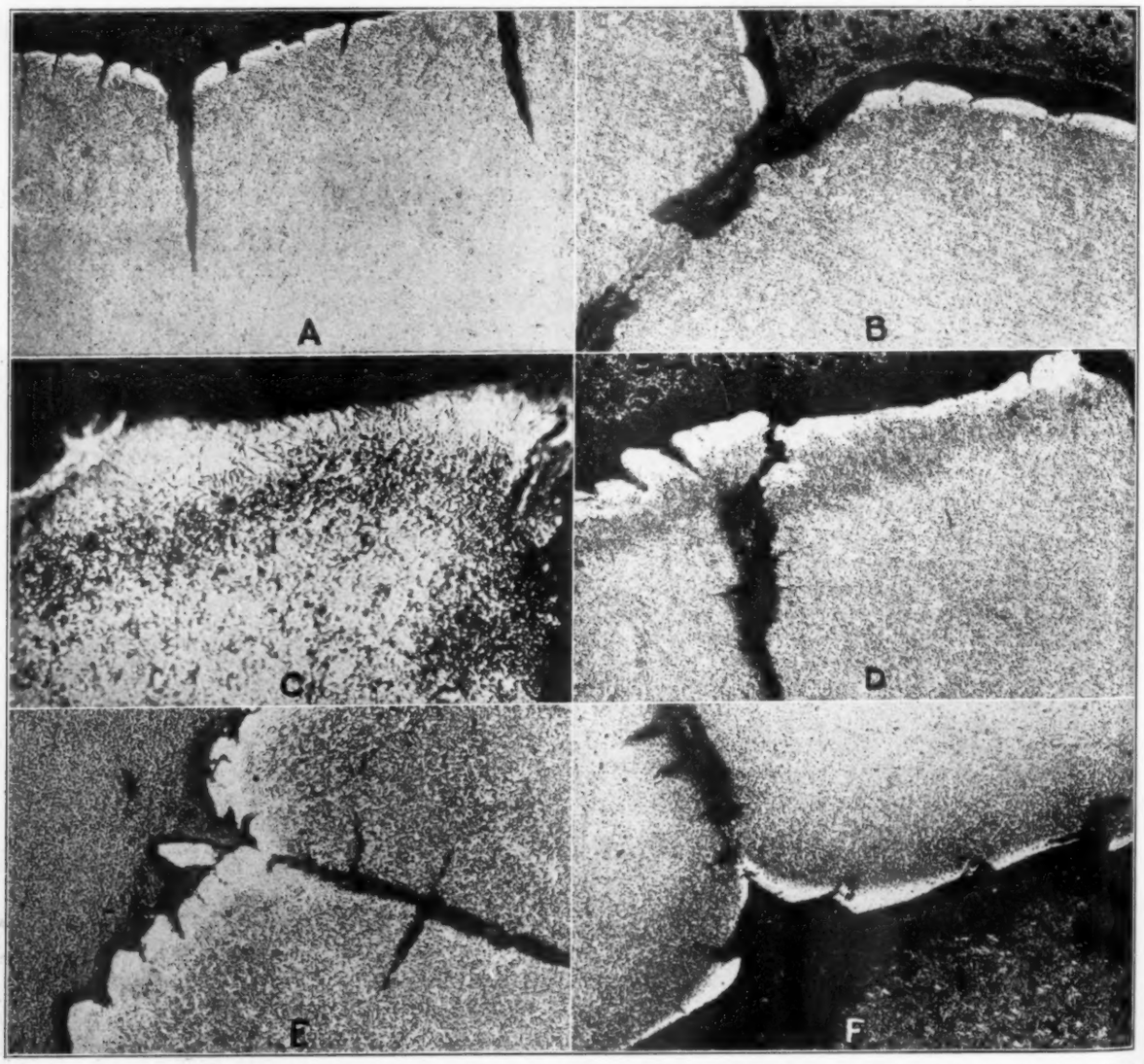


Fig. 1. Cross-section Micrographs Showing Typical Structure Changes in the Bore Surface of Machine Gun Barrels After Firing. Note the white surface layer (Martensite) and the underlying darker layer (Troostite). X 100, except Fig. c, which is X 500: (a) Standard Steel. Barrel No. 1 B; (b) Steel. Barrel No. 4 C; (c) Chrome-Vanadium Steel. Barrel No. 6 B; (d) Nickel Steel. Barrel No. 13 C; (e) One per cent Nickel, high Manganese Steel. Barrel No. 17 B; (f) Tungsten Steel. Barrel No. 19 C.

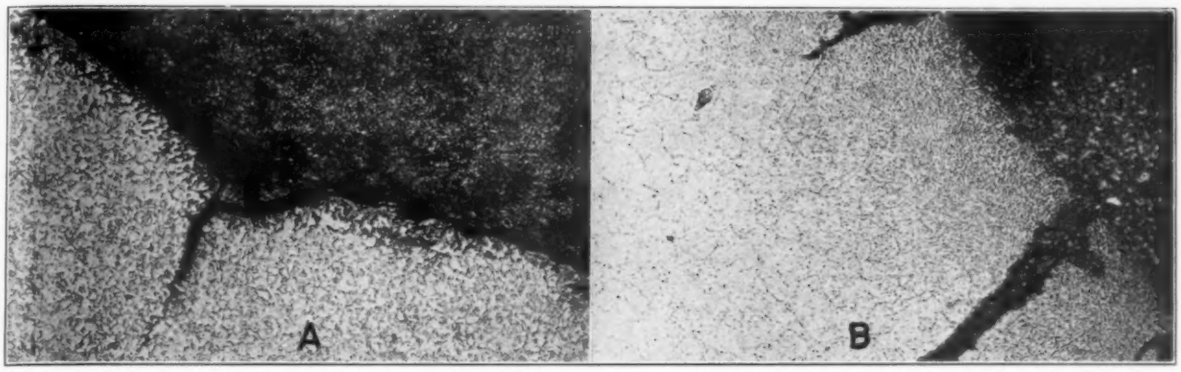


Fig. 2. Cross-section Micrographs of Machine Gun Barrels of Special Steels which showed no Pronounced Change in the Bore Surface After Firing. X 100:

(a) Barrel No. 12 C, low carbon, high silicon steel. The white layer is absent; dark layer can be seen at the extreme edge of the section. (b) Barrel No. 20 C, stainless steel. The only change produced in the structure of this steel is the very faint darkening at the extreme edge within short distance of the breech end.

(1.5 cm.) from the origin of rifling where most severe cracking and a more deeply affected layer were found. The total depth of the affected layer varied from .07 mm. to .93 mm. for barrels of different compositions sectioned at this point. This structure appeared as a white layer along the surface of the rifling, with an underlying one which etched dark and resembled troostite in this respect.

The white layer was not affected by etching and remaining bright (Fig. 1). This layer extended over the surface of the bore for a distance of 2 inches from the origin of rifling and was about .05 mm. in thickness. Its thickness was maintained along this entire distance although it varied slightly for steels of different compositions. The white layer was not found in barrels of low carbon high-silicon chromium-vanadium steel or of stainless steel (see Fig. 2). No trace of this white layer was found beyond the first two inches of the rifling. On the other hand a darkened layer which decreased in thickness toward the muzzle covered the bore surfaces for a distance of 10 inches from the origin. Its depth at the 10-inch point was almost negligible, however.

Cases were noted in which a distinct martensitic pattern was found in the white layer (Figs. 1c, and 3a and b). Rosenhain and Belaiew[2] have similarly reported a fine martensitic structure in similar cases.

Scratch hardness tests (Fig. 3), showed that this surface layer was considerably harder than the original steel. Its hardness and extreme brittleness permitted it to be chipped from the bore surface during firing. Special precautions are necessary to prevent this surface layer from being chipped off during sectioning and polishing of the specimens prior to microscopic examination. Sections were mounted in an alloy of low melting point in the manner well known to metallographists for convenience in polishing.

Both the white and underlying darkened layers were found also along the walls of the cracks. However, a definite width of the crack seemed to be necessary to

[2]Rosenhain, W., and Belaiew, N. T.; Proceedings International Association for Testing Materials; N. Y.; 1912; Section 1, p. 127.

Table I. Results of Carbon and Nitrogen Determinations.

No.	Type of Steel	Analysis of steel as determined before manufacture of barrels								Average depth of affected structure at critical point of erosion in m. m.	Sample	Carbon (per cent)	Increase in Carbon (per cent)	Nitrogen [1] (per cent)	Increase in Nitrogen (per cent)
		C	Si	Mn	Ni	Cr	V	S	P						
1	Standard.....	.49	.12	1.21	.....	.....	.....	.05	.05	.89	1st cut (.004″)	.67	37	.033	410
											2nd cut	.56	14	.049	610
											3rd cut	.....		.028	350
											original steel	.45	.....	.008	.....
4	Carbon steel..	.60	.25	.92	.....	.....	.....	.03	.02	.13	1st cut (.005″)	.78	30	.060	765
											2nd cut	.71	18	.026	290
											original steel	.58	.....	.009	.....
6	Chromium vanadium.	.27	.09	.44	.....	.57	.12	.03	.01	.25	1st cut (.004″)	.42	56	.002	decrease
											2nd cut	.31	15	.000	decrease
											3rd cut	.....	.....	.006	50
											original steel	.27	.....	.004	.....
20	Stainless (high chromium).	.25	.62	.39	.....	13.55	.....	.015	.015	none.[2]	1st cut (.004″)	.82	148	.000	.....
											2nd cut	.....	.....	.004	decrease
											original steel	.26	.....	.009	.....
13	Nickel.....	.33	.09	.78	3.59	.....	.....	.035	.015	.16	1st cut (.005″)	.48	45	.039	485
											2nd cut	.43	30	.050	625
											original steel	.33	.....	.008	.....
12	Low carbon, High silicon Chromium Vanadium.	.12	.85	.05	.....	.85	.23	.04	.02	.07	1st cut (.004″)	.34	183	.000	.....
											2nd cut	.16	33	.013	63
											original steel	.13	.....	.008	.....

[1]Deviations of less than 0.005 % in the nitrogen determinations are of little significance on account of the small samples available for use.
No definite line of demarcation could be measured.

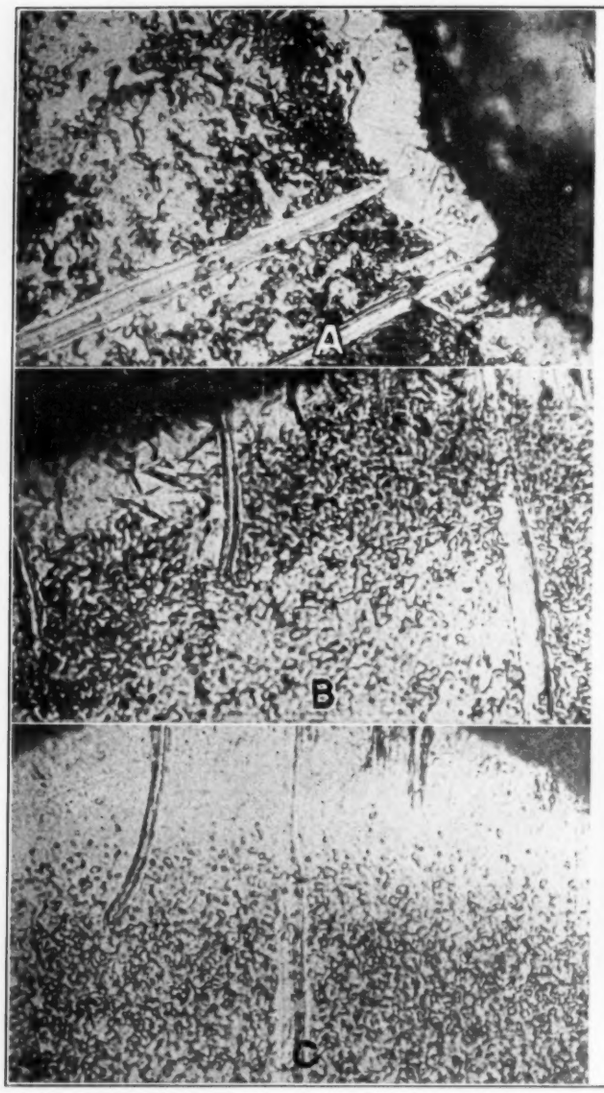


Fig. 3. Cross-section Micrographs Showing Results of Hardness Determinations by the Scratch-Hardness Method.
Note the pronounced decrease of the width of the scratch in the surface layer as compared with the same in the underlying metal. X 850: (a) Barrel No. 2 B; (b) Barrel No. 6 B; (c) Barrel No. 19 C.

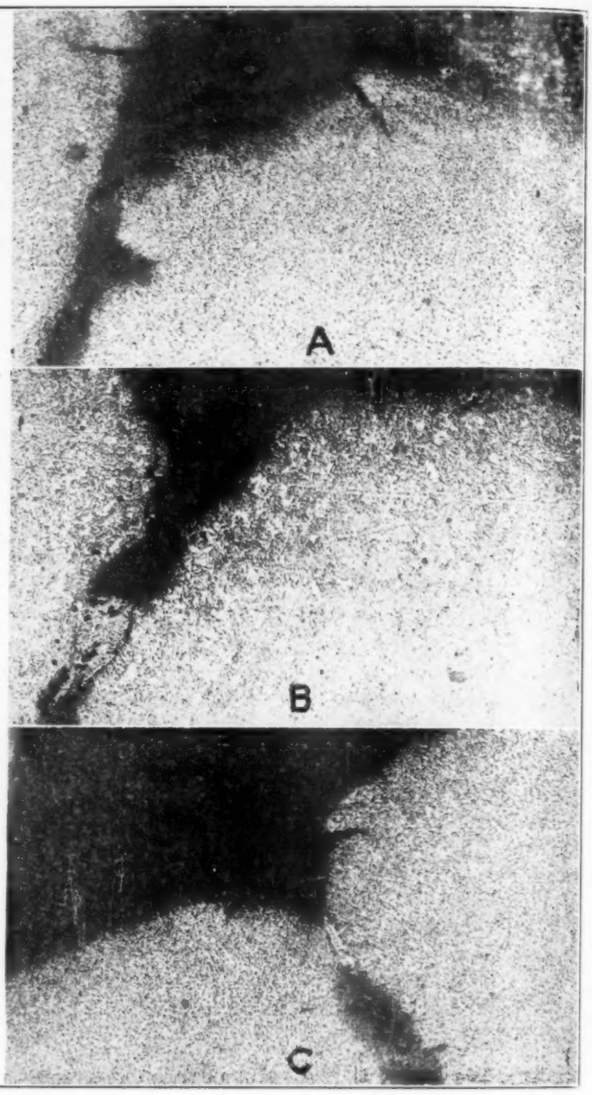


Fig. 4. Cross-section Micrographs Showing Effect of Tempering on the Hardness Layer of the Bore Surface of Machine Gun Barrels. X 100:
(a) Barrel No. 13 C. Tempered for 30 minutes at 270°C. air cooled. Compare Fig. 1 (d) for micro-structure previous to heat treatment. The change produced upon white layer is not complete; some of it is left unchanged. (b) Barrel No. 4 C. Tempered for 45 minutes at 323° C. air cooled. Compare Fig. 1 (b). The hardened white layer is changed and has a troostitic appearance. (c) Barrel No. 19 C. Tempered for 30 minutes at 390° C. air cooled. Compare Fig. 1 (f).

permit the change to progress very far as the side walls of some of the narrower cracks did not show a change all the way down to the ends. The cracks permit gas to enter only to a certain depth and the penetration also depends on the time during which the pressure impulse is active.

The theory advanced by Fay[3] as to the nature and formation of this white layer is that the skin of the metal of the bore is heated by the hot gases of combustion to a point well above the critical point and perhaps even beyond the melting point. The surface is instantly chilled by the large mass of metal and the formation of martensite results. The hardness of the surface of the gun tube is due, says Fay, to a combination of mechanical deformation and the process of martenization. He found that steel, cold-worked in certain portions by stamping with a steel die and exposed to firing conditions, showed a white layer on the cold-worked areas much more pronounced than in the unworked areas.

As Wheeler[4] pointed out, however, this theory does not account for the formation of a white layer in the powder chamber. Besides, it is believed that the cold-worked layer, once formed, would be tempered by hot gases following the bullet, as the combustion of powder in the case of the machine gun is not completed even when the bullet leaves the muzzle of the gun. Wheeler's theory is that the hard layer of the eroded gun is a locally cold-worked austenitic case caused by penetration of nitrogen. Nitrogen under pressure and with heat penetrates and combines with steel.

The specimens which showed the presence of the white layer were tempered at 250° C., 320° C., and 390° C.. The temperature 250° C. was too low to produce a noticeable

[3]Fay, H.; Trans. A. I. M. E.; Vol. LVI; 1916.

[4]Wheeler, H. E.; Nitrogen in Steel and the Erosion of Guns; I. M. M. E.; Vol. LXVII; 1922; p. 257.

tempering effect on the hardened layer. A partial darkening occurred upon etching but traces of the white layer still were found (see Fig. 4a). After heating to 320° C., as well as to 390° C., the hardened layer changed completely to the darkened form. This treatment indicated that the white layer could not be a nitride of iron because iron nitride does not readily decompose below 450° C. It can not be austenite, as on slight tempering it would pass to martensite and not troostite. It is believed, also, that the air-cooling during firing is insufficiently rapid for austenite to form. Therefore, the white layer corresponds to martensite. The white layer was absent in barrels made of steel of low carbon content or of stainless steel, which latter originally had a martensitic structure (see Fig. 2). On the other hand the probability of absorbed nitrogen remaining in solution should not be neglected, since in such a case the layer may have a martensitic character and change at temperatures below the decomposition temperature of nitride.

Nitrogen determinations were made of layers reamed from the bore surface within which this layer is present. Cuts were made for 1.5 inches from the origin of rifling along the bore, two, and in some cases, three successive cuts of .004 inch (.10 mm.) or .005 inch (.13 mm.) being made. These samples, as well as drillings of the unchanged wall of the barrel (to check the nitrogen content of th barrel itself) were analyzed for nitrogen. The percentage of total nitrogen was found to be of the order of hundredths of one per cent and is higher than normal for these crucible steels although too low for assumption that the white layer consists of iron nitride.[5]

Absorption of carbon by the steel was believed likely to take place under the conditions of firing where high temperature and pressure exist. In order to test this possibility, analyses were made for carbon of the surface layers from the breech end of the bore surface. The analytical data which are given below, Table I, show a considerable increase in carbon with a high concentration in the first cut.

[5]These determinations were made by Mr. Louis Jordan, Chemist, Bureau of Standards.

The analyses show higher carbon in the first cut and the increase in carbon is considerable as compared with the original carbon content of the steels. The results indicate that the carbon which was absorbed from the products of combustion carburizes and hardens the bore of the barrel. While a very large increase in nitrogen is often shown, no such increase in nitrogen was found in barrels Nos. 6 and 20, although steel No. 6 showed the white layer. The increase in nitrogen in steel No. 12 was also very much less than in the other steels in which an increase in nitrogen was found. The above results indicate strongly that the chromium content of the steel is an important factor determining the rate of nitrogenization. It will be noted that steels 6, 12, and 20 all contained chromium.

This conclusion seems justified in spite of the fact that the Allen method for nitrogen, used for these samples, probably does not determine nitrogen if present as chromium nitride and thus may give values with chormium steels that do not represent the total nitrogen content. However, the nitrogen determined in the drillings representing the original steels is not lower in the chromium steels than in the non-chromium steels, a fact which may be taken to indicate that no considerable proportion of the nitrogen in chromium steels is present as chromium nitride. Further, in the case of the absence of any significant increase in nitrogen in the bore surface of the chromium-bearing steel barrels 6, 20, and 12, it is more reasonable to assume that nitrogenization actually has been retarded than that nitrogen absorption has taken place but entirely by the formation of chromium nitride. Nitrogenization may or may not be concomitant with carburization. Carburization occurs in all cases. The absorption of carbon, rather than of nitrogen appears to be the primary cause for the formation of the hard white layer. The formation of the hard layer and its flaking off from the surface with subsequent shots would naturally hasten erosion and contribute to the destruction of the rifling in the bore of the gun.

(Author's Note: The author acknowledges with thanks the valuable help of Mr. J. S. Vanick, Research Operator of the Ordnance Department, who assisted in conducting the experiments outlined in this article.)

Symposium

COGNIZANT of the importance of the research reported by Captain de Sveshnikoff in the foregoing article, ARMY ORDNANCE invited several of the more important authorities on gun barrel erosion to comment upon the conclusions arrived at by the author. These discussions are presented in full below.

In addition, some very interesting comment was obtained from individuals and organizations who, while not able at this time to enter into a more detailed discussion, expressed the following opinions:

COL. WM. H. TSCHAPPAT, *Commanding Officer, Aberdeen Proving Ground*:—

"Captain de Sveshnikoff has made careful determinations of the metallurgical changes which took place in the metal surrounding the badly eroded parts of these barrels, which were of several different compositions. He has shown that a decided increase in the carbon percentage resulted in each barrel and that sometimes an increase in nitrogen also resulted, though the percentage of this element was in all cases very low.

"The author concludes that the carburization and the formation of a hard surface next to the bore would hasten erosion.

"That high carbon steel erodes faster under the action of fast moving hot powder gases has been proved by tests in which these gases escape through small openings in plugs made of steels of various compositions. It is believed that the author is justified in his conclusion and that he has made a valuable contribution to the metallurgical side of the erosion of small arms. The primary cause of erosion remains as the mechanical action of fast moving gases under high

pressure escaping in the small opening between the bullet and the side of the bore. Erosion will take place in steels of any known composition."

MR. GEO. W. STRUBLE, Manager of Ordnance, Bethlehem Steel Company:

"We find that the micro-structure of the type barrels as affected by the heat of rapid firing from the same shows a condition similar to that resulting from a wheel burn on a rail, the only difference being that the rail does not absorb any carbon or nitrogen."

MAJOR J. C. GRAY, ORD. RES., *Small Arms Division, Technical Staff, Office of the Chief of Ordnance*:

"Aside from all consideration of the actual physical and chemical effect of carburization, the studies which have been carried on are of particular interest from another point of view; namely, that of cleaning small arms.

"The photographs, it will be noted, indicate a surface condition showing structural changes in the bore surface of a machine gun barrel which are of considerable interest.

"It will be noted that the cleaning of machine gun and rifle barrels has been the subject of controversy for years and various methods for accomplishing proper results have been proposed from time to time.

"A study of the micrographs indicates one reason why it has been found so difficult to properly clean machine gun barrels, when we consider that all of the minute cracks which undoubtedly occur on the bore surface are filled with powder and primer residue of a highly corrosive nature when combined with water from the atmosphere.

"The photographs, and study in general, have served to clear up a point which has been in controversy; namely, that of a possible accumulation of gas in the pores of the steel, somewhat after the fashion in which water is held in a sponge. It would appear that any such opinion concerning the gas actually being suspended in a gaseous state in the bores of the steel is in error.

"However, it is noted that in Table I a very considerable increase in the percentage of nitrogen content in the standard steel barrel is indicated and it has been concluded that the steel bore surface is case-hardened as well as physically cracked.

"It is interesting to note that of the alloy steels, such as chrome vanadium or high chromium type, there is practically no nitrogen indicated in combination with the steel at the bore surface."

The Cause of the White Layer

By

DR. HENRY FAY

Massachusetts Institute of Technology

CAPTAIN DE SVESHNIKOFF has produced interesting and important results in his article entitled "Carburization as a Factor in the Erosion of Machine Gun Barrels." He, however, leaves us somewhat in doubt as to the cause of the hard white layer. After apparently accepting martensitization as the cause of the hard layer, and after having shown that absorption of the carbon and nitrogen takes place he remarks in his final paragraph that "absorption of carbon rather than nitrogen appears to be the primary cause for the formation of the hard white layer."

Some time ago the writer published a paper entitled "Erosion of Guns—The Hardening of the Surface"[1] in which the theory was put forward that the hard white layer was due to the steel having been heated considerably above Ac, and that the heated surface was maintained in the martensitic condition by the rapid chilling of the cold metal below the surface. It was shown further that the metal which was cold worked by the rotation of the projectile had a marked tendency to go over to the martensitic condition. This was shown particularly on the lands and the forward part of the gun on the driving edge of the lands only. Objections to this theory have been offered in that it does not account for the hardness of the explosion chamber. Further objection has been raised by Wheeler who showed that nitrogen was absorbed producing a hard white layer, but unfortunately he made no analyses either of the metal or the gas which he used, so that these results are of small value. The conditions for taking on either carbon or nitrogen or both seem to be ideal on account of the high pressure and high temperature especially when those powders are used which on decomposition give an excess of carbon monoxide over carbon dioxide. The equilibrium phenomena are however very complex and vary with the powder which is being used and to a lesser extent the composition of the steel.

The writer has shown in an article entitled "Nitrogen and Case-Hardening"[2] that steels are nitrogenized as well as carburized in case-hardening operations, the absorption of nitrogen preceding that of carbon. The presence of nitrogen in case-hardening materials is a distinct aid to carburization and the latter process takes place at temperatures below Ac, in nitrogenized steels. Accepting Captain de Sveshnikoff's results the writer offers the following modification of his original explanation of the hard white layer:

(1) A hard layer, martensitic or troostitic in character will be found in those parts of the gun which have been suddenly heated above Ac.

(2) The formation of this hard layer will be accelerated by cold working the metal, the absorption of nitrogen, and of carbon.

[1] Fay, A. I. M. E., Vol. LVI—1916.

[2] Chem. & Met. Eng. Vol. 24, No. 7—Feb. 16, 1921.

(3) The absorption of carbon will never take place to such an extent as to show free cementite because the rate of erosion will always exceed the rate of diffusion of the iron carbide.

(4) The hard layer should show higher concentrations of both nitrogen and carbon than the original steel.

The amount of carbon which will be absorbed in large caliber guns may be influenced by the smearing of copper over the surface caused by the wearing of the rotating band. Whether or not this would affect the absorption of nitrogen is not known but it certainly should retard the absorption of carbon.

Captain de Sveshnikoff has stated that he has found the hard layer on the surface of cracks. The writer has examined a large number of photographs showing cracks in large caliber guns and he has never in a single instance found the presence of a hard layer in a crack no matter what the size. Professor Howe[3] has also failed to find the hard layer on cracks and offers an elaborate explanation for not finding them.

Erosion of Machine Gun Barrels

By

W. T. GORTON, Ord. Dept., U. S. A.

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THE erosion of barrels is a subject which has been investigated by a great many tests at Springfield Armory and elsewhere. Wear of the barrel interior is, of course, due primarily to the heat and friction incident to the combustion of the powder charge and propulsion of the projectile through the bore. If firing is conducted at so slow a rate that the bore is permitted to cool between rounds, the destruction of the interior of the barrel proceeds quite slowly and uniformly, each round contributing its increment of damage independently. This is the usual condition for small arms other than automatic arms. If firing proceeds rapidly, with no opportunity for the interior of the barrel to cool between rounds, wear is greatly accelerated due to the considerably greater damage occasioned by passage of a projectile through a hot barrel than through a cold one. This is the condition under which machine guns generally must operate. With the more extended use of, and interest in, these weapons during the last few years, and because erosion most directly concerns them, this problem has been investigated chiefly by machine gun firing.

While the main causes of erosion are well known, the secondary causes and the manner in which they operate present many difficult problems. Analysis of what actually takes place inside the barrel involves evaluation of each of the various phenomena, one of which is discussed in Captain de Sveshnikoff's article.

Investigations which have been conducted include principally tests of barrel materials and forms of rifling, with some study of the comparative effects of various powders, chamber pressures, and bullet forms and materials. Results relating to barrel materials and forms of rifling are to all intents and purposes negative, in that no way of effecting any great improvement has been discovered. The standard chrome barrel steel such as is used in .50 caliber machine gun barrels is probably the most satisfactory of any material tried to date, and no other form of rifling has been shown to be noticeably superior to the standard form used in all our small arms. There are practical limitations in this connection, of course. It is entirely possible that more suitable materials or rifling forms might be developed if such factors as suitability for machining could be ignored.

The extent to which erosive effects of different powders, variation in chamber pressures, and different bullet forms have been investigated and compared is not known, but the suggestion is offered that in this direction there may be prospect of improvement. The limitations imposed by required exterior ballistics are recognized to be very severe, but perhaps may not be insurmountable. If degrees of erosion at various points in a given barrel were evaluated on the same comparative basis and plotted to a convenient scale as ordinates whose corresponding abscissas represent lengths to each point respectively, the resulting curve would be surprisingly like the pressure curve. This can mean but one thing, namely, that high temperature of the bore is the main underlying cause of erosion. Whether improvement in this respect is possible, and if so, the degree to which it may be carried remains to be seen.

Additional Tests Needed to Determine Value of Various Steels

By

J. S. VANICK

International Nickel Co., Bayonne, N. J.

HAVING been closely associated with this work in its progress, it is doubtful whether I can add an amplification or a more detailed interpretation to the nucleus of data compiled in Table I and in the few thermal tests for martensite, austenite and combined nitrogen.

At 250 shots per minute, the total firing time for 11,000 rounds could not exceed 45 minutes, which would represent the maximum time of cementation by the powder gases. At least ten cycles of coming up to maximum temperature and cooling again, would be included

[3] A. I. M. E. 1918.

in the interruptions to the firing, thereby further reducing the "time at cementation-temperature." The temperature gradient is very steep in the zone adjoining the bore of the barrel and then probably assumes the more normal slope in agreement with the thermal conductivity of the steel. The depth of the "affected structure" reported in Table I represents the depth which is heated to a temperature high enough to permit cementation. Of the maximum depth reported in Table I (.89 mm.), only a small portion is actually cemented as the additional data show. The "white" or hard layer is again, only a part of the cemented zone.

The "hard," or "white," etch-resistant film forming on the fissure or crack walls apparently consists of a structureless pulp impregnated with products of the combustion of the powder in either the combined or occluded form. There is no evidence of deformation in the layer. The layer is undoubtedly formed by the fusion of the skin of the bore as it is scorched by the hot blast of the explosion. Fusion or burning, ordinarily implies oxidation, but the composition, pressure and temperature of the gases is such as to exclude oxidation. The principal elements available for combination with the metal, are nitrogen, carbon and hydrogen. Compounds of hydrogen are unknown; those of nitrogen are unstable at fusion temperatures under ordinary conditions and carbon alone remains for combination. The carburization of a thin, "fused," skin could then be expected and nitrogenization might occur during the brief period of the explosion impulse. The depth to which carbon and nitrogen would penetrate would be dependent upon the resistance or encouragement which the different alloy steels offered. Chromium and vanadium resist the penetration of carbon while nickel and the low carbon steels permit or encourage it. The effect of this influence is roughly expressed in the data of Table I. The high chromium, low carbon steel shows a large increase in carbon, over the initial composition, in the first layer removed; followed by a small increase in the second layer. The "stainless" steel would undoubtedly show the largest increase in carbon if its carburized skin were more adherent and the .004-inch cut which included its carbon-penetrated zone were undiluted by a relatively large quantity of material of the original composition.

Similarly the carbon and nickel steels show a carbon penetration for a greater depth; the carbon concentration gradient thus set up agreeing with the encouragement which low carbon and nickel steels grant to the infiltration of carbonaceous gases.

The increase in nitrogen apparently follows the same general rule. The influence of the gases upon accessory elements (Si, Mn) which are present in significant quantity in the steels, is less thoroughly understood.

Carbon resists the penetration of nitrogen in short-time exposures in reducing gases and its influence in that direction is apparently borne out in the results for steels Nos. 1 and 4. Nickel steel appears indifferent to the penetration. Nitrogenization is, in general, better accomplished at sub-fusion temperatures and some indication that most of the nitrogen that had penetrated the steel had filtered deeper and remained in the cooler strata, is borne out by the analyses of steels 1 and 13. Speculations regarding the relation of the nitrogen-deterioration-values to the composition of the steels are especially hazardous in view of the 10-20 per cent error to which the determinations are liable.

The significance of the carburization and nitrogenization factors in affecting the life of the rifling is apparent but the evaluation of the merits of the several steels in resisting erosion is not accomplished in this report. It is generally known that a high-carbon steel is more rapidly eroded by the hot gas blast than the low-carbon steels. The ordinary rifle barrel steel is more rapidly eroded when it is structurally in the hard martensitic state, than when it is in the sorbitic state. Neglecting other factors which determine the selection of a gun barrel steel and considering only the properties of hardness and ease of fusion associated with the character and formation of the affected skin, it remains to be determined whether in steels of the carbon, nickel or chromium type, the shallow and steeper concentration gradient of gas-reaction compounds piled up in the bore-surface of the chromium type steels does not, by its hardness and brittleness when cold or its softness and lowered fusion point when hot, permit a more rapid erosion than the deeper and more gradual concentration gradient of gas-reaction compounds in the nickel and plain carbon types of steels. It is quite probable that the plain carbon and nickel steels would prolong the life of the rifling for that portion of the firing-life spent in the accumulation of an impurity-rich skin.

The Nitrogen Theory of Erosion

By

H. E. WHEELER

IT would seem that the experimental data offered in Table I should be considered with the following reservations:

1. Is it impossible to assume that the eroded surfaces of the gun barrels were entirely free from foreign matter (unburned powder, etc.) containing carbon or nitrogen or both?
2. The nitrogen determinations would not include nitrogen in solid solution. My own work on this subject led me to the conclusion that only the nitrogen in solid solution was effective in this action.

I cannot subscribe to the author's statement, "The absorption of carbon, rather than of nitrogen, appears to be the primary cause for the formation of the hard white layer." It appears that his results might equally well be interpreted to prove just the opposite of this statement. A complete exposition would require lengthy references to my own report on this subject, but I would like to call attention to the following points:

In the first place, the nitrogen theory of erosion assumes that the white layer is an austenitic case caused by the alloying effect of nitrogen with consequent lowering

of the Ar_1 point to such an extent that the solid solution phase is formed on the surface.

That nitrogen has such an effect on steel can no longer be doubted.

The above theory assumes the presence of carbon, and more or less carbon does not effect the basal theory at all.

Take the case of steel No. 4 from Table I where the carbon increased from .58 to .78, or the case of steel No. 13 where the carbon increased from .33 to .48. Without the effect of nitrogen, how could these increases in the carbon content be assumed to produce a martensitic case?

In my work, I demonstrated, at least to my own satisfaction, the identity between the white layer in an eroded gun and the white layer produced in Haber process cylinders and the white layer produced when samples of steel are heated in a stream of NH_3. If this identity is a fact, the white layer was actually formed in some cases, accompanied by decarburization. In fact, the effect was at first ascribed erroneously to decarburization. I would consider that whether partial carburization or decarburization takes place is a matter of no great consequence, dependent simply upon the concentration of carbon in the steel and the concentration of carbon and hydrogen in the gases.

The carburizaton theory offered by the author fails to account for certain effects noted in my report. For instance, I showed that the original ferrite network projects well into the white layer (Figs. 48, 49, 50. I. M. M. E., Volume LXVII). We should certainly expect a carburizing action to be selectively faster in the ferrite areas than in the pearlite areas. Such is not the case, however.

Also I showed that while copper-bearing reagents fail to deposit on the ferrite areas of normal steels, they deposite copper selectively on the ferrite areas of normalized steels known to contain nitrogen. (Figs. 22, 23.) I then showed that this same action was evident in the areas adjacent to the white layer in eroded gun tubes. (Figs. 54, 55.) This is satisfactorily explained by the assumption that nitrogen in the white layer diffuses through the piece during the process of normalizing. What explanation can be given, disregarding nitrogen?

Many other similar points which the carburization theory fails to account for are omitted for the sake of brevity.

The best test of a theory is whether the allowable hypotheses which can be evolved on a basis of the theory will stand up to the facts. One of my hypotheses was that we could expect the white layer to be less evident in steels containing chromium and other alloying constituents which tend to prevent the formation of the solid solution phase. The evidence in this paper further supports this assumption.

If the carburization theory is correct, we can assume that high carbon steels will show deeper and quicker formation of the white layer than low carbon steels. The evidence refutes this. (Compare Table I, steel No. 1, and steel No. 4.)

In short, I feel that the nitrogen theory of erosion fits more perfectly with all the known facts than any theory which has yet been offered. The fact that martensite does not seem to form as the result of tempering the white area does not prove that the white area is not austenitic in character. We cannot necessarily expect that austenite resulting from nitrogen would behave exactly the same as austenite containing some other element in solution. My work showed that in austenitic areas produced by NH_3, the martensite phase was present, but extremely transient, so that it could only be photographed in nickel steels and then only when a section was cut at such a bias angle as to spread out the exposed martensitic area.

An interesting side-light on the mechanical aspect of gases penetrating steel under high pressure is furnished by the work of Professor P. W. Bridgman (*Mechanical Engineering*, March, 1925, page 161). He showed that hydrogen under a pressure of 9,000 atmospheres will penetrate instantaneously a steel cylinder of any thickness at room temperature. He considers that it is probable that all gases act in a similar way, but less rapidly.

In conclusion, I should like to say that actual experimental results, such as the author has given us in his paper, are of great value. It would seem that the experimental evidence now available is quite ample to justify a real test on a large caliber rifle of chrome vanadium steel. Machine gun experiments are inconclusive if the results are to be applied to large callibers because the machine gun is an extreme case of sustained fire, the resultant temperature rise from one shot being cumulative with the next.

A large rifle of chrome vanadium steel would not cost much more to make than one of the usual nickel steel. It is untenable to suppose that such a gun would not be at least as satisfactory as the present guns. On the other hand, there is every experimental reason to expect that it would be infinitely better than nickel steel in its resistance to erosion. Such an experiment, of course, is not of great interest to, nor within the means of anyone but the Ordnance Departments of the Army and Navy.

The Ordnance Department of the Army made an appropriation for such an experiment during the war on a 75-mm. field gun, but the appropriation was cancelled with the signing of the Armistice before the experiment had been carried out. It is to be hoped that this experiment will yet some day be made and preferably on a caliber as large as twelve inches.

Old and New Theories in Gun Erosion

By

LT. COMDR. A. G. ZIMERMANN, U. S. N.

U. S. Naval Gun Factory

EARLY investigators of erosion dwelt largely on the wearing away action of gases in high powered guns and shaped their experiments to show the effect of streams of powder gases on various metals, or the same metal after different mechanical or heat treatments. Osmond[1] in the same volume containing the account of Vieille's experiments had a *"Note sur la trempe superficielle de l'acier soumis a l'action des explosifs."* Thereafter this hardened layer received much attention from

[1] *Mémorial des Poudres et Salpêtres*, T II, 1901.

various commentators, while the purely mechanical removal of metal by gases at high velocity leaking past the projectile was more and more relegated to the background. Thus, by 1920, Wheeler[2] definitely discarded this factor as an important influence in erosion, pointing out that it was the first theory advanced and stating that by then it was very largely discredited by "those who have made a careful study of the question."

The natural conclusion reached as a result of concentration on gas erosion by early investigators was that materials were efficient for gun bores as their melting points were higher. Howe[3] showed that this could not be a true measure of efficiency against erosion. Nevertheless there have been experiments made from time to time at the Naval Proving Ground along the lines pursued by the pioneers, so that the effect of powder gases passing through small vents has been further investigated. It may be of some interest to compare a few results obtained from erosion plugs with results from used machine gun barrels examined by Captain de Sveshnikoff. It was difficult to find steels of even approximate chemical composition since the records, particularly the older ones, are somewhat fragmentary.

All of the plugs were 5⅛ inches long and 0.718 inch in diameter, (one end having an enlargement to form a shoulder) with a bore about 0.16 inch in diameter through the center. The shoulder secured the plug in its holder against the pressure generated by 2½ pounds of smokeless powder, 25 grams of cannon powder (for ignition) and a 15-grain electric detonator all in a chamber of about 207 cubic inches capacity. The products of combustion passed through the hole in the plug. Maximum pressures were determined by the average readings of three crusher gages placed in the chamber. At first results were recorded in grams loss in weight, but it was seen that per cent loss in weight would make a truer comparative figure between metals of different specific gravities, the plugs in all cases being machined to the same dimensions. The appearance of the plug bores or vents after firing was carefully noted in the earlier tests. Usually they were slightly out of round, with longitudinal scores, the inlet edge of the vent being decidedly rounded. It was noted that the presence of inclusions in the steel increased the depth and irregularities of the scores.

It will be seen that as far as resistance to sustained gas action alone is concerned, the materials compare directly as the per cent increases in nitrogen and inversely as the per cent increases in carbon, as determined by de Sveshnikoff. How far this order of superiority squares with the actual results on the gun barrels is not known, but it is well known that the expansion of machine gun barrels is extensive[2] and thus the destructive effect of gas leakage past the projectile with the gun overheated cannot be of as high an order as if the clearance were very small indeed. This point will be elaborated later.

It is noted that Knight and Northrup[4] made the same scratch hardness test on a white layer produced by ammonia at elevated temperatures as de Sveshnikoff has on the layer in gun barrels, and with the same results. Knight (in 1917) first suggested that the action of nitrogen on the material of the bore played a considerable part in erosion and Wheeler pointed out that nitrogen present as nitrides was not the whole story, adding that, from Professor Richard's viewpoint, a few hundredths of one per cent of nitrogen would have the same effect on steel as several per cent of some other alloy. It is understood that the Allen method of determining nitrogen includes only that portion of the element present as easily decomposible nitrides. In this case there must be affirmative evidence that there is no nitrogen present in form other than nitride, before the determinations in de Sveshnikoff's investigation can be considered as having a quantitative bearing on Knight's hyopthesis.

A metallographic examination was made of an erosion plug having 0.82 per cent nickel and 0.23 per cent carbon. The normal structure is shown in Fig. 1. Two cross sections were examined, one near the inner (high pressure) end, the other near the outlet end. The maximum pressure developed was 16.82±.6 tons per square inch. The specimens were mounted with low melting point alloy

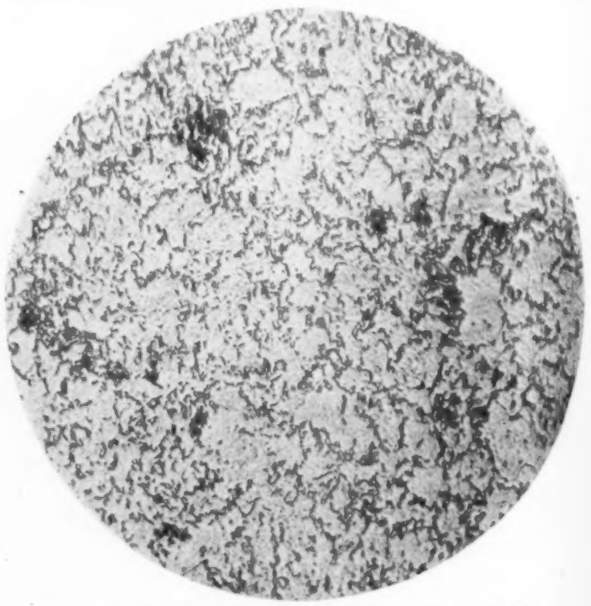


Fig. 1. Normal structure of erosion plug. 15 sec. HNO_3. Mag. 500

TABLE I.

Results of Gas Erosion on Material

Type	C	Si	Mn	Ni	Cr	V	S	P	Maximum Pressure Tons sq.	Weight Lost in Grams	Average Loss	Per cent Loss in Weight
Cr. V 1	.35	.22	.55	--	.94	.20	.015	.013	16.95	36 96		(*)
2		Same							18.07	34.41	36.34	(*)
3		Same							19.23	37.66		(*)
Stainless 1	.03	--	.12	.41	14.42	--	--	--	17.89	48.54		16.97
2		Same							18.36	48.26	47.51	16.86
3		Same							18.77	45.73		16.00
Nickel		Presumably 2.8 to 3.5 per cent Ni.							18.41	35.58	35.58	(*)
Nickel		Bar Stock, 3 per cent (?) Ni.							17.31	29.87	29.87	10.3

*Unknown.

2Wheeler:—Nitrogen in Steel and the Erosion of Guns. *Min. & Met.* No. 160, 1920.

3H. M. Howe; *Trans. A. I. M. M. E.* Vol. LVIII, 1918.

4O. A. Knight & H. B. Northrup:—Some Notes on the Effect of Nitrogen in Steel. *Chem. & Met. Eng.* Vol. XXIII, No. 23, 1920.

in the bore and polished. Visual examination in the unetched condition showed a narrow ring of metal in relief (apparently harder) at the edge of the bore. When etched and examined, the bore of each specimen showed the white layer characteristic of eroded gun bores but no erosion or heat cracks. As the mounting alloy caused scratches in polishing, it was removed and the surfaces of the specimens improved by a light repolish.

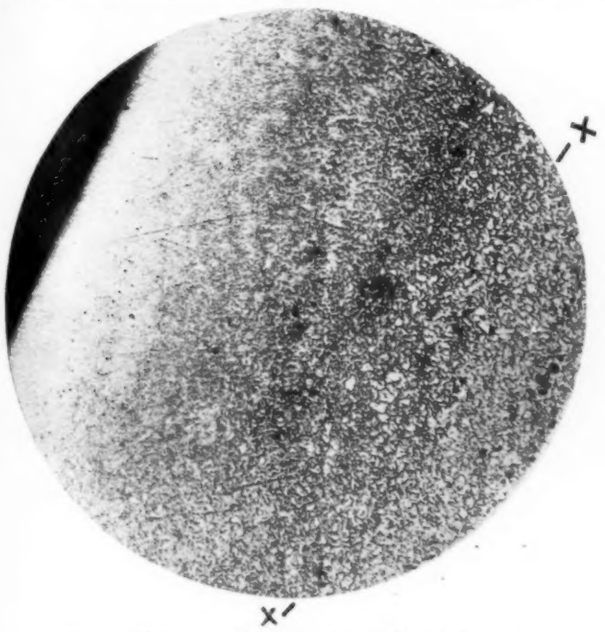


Fig. 2. Bore near inlet. 30 sec. HNO_3. Mag. 100

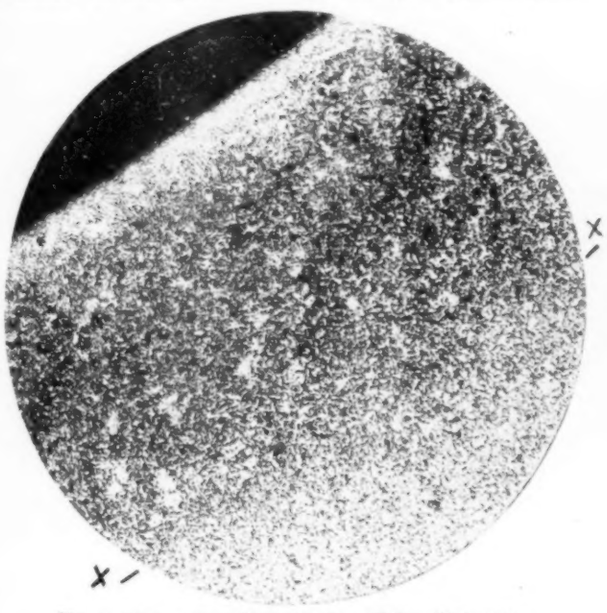


Fig. 3. Bore near outlet. 30 sec. HNO_3. Mag. 100

Fig. 2 shows the edge of the bore near the inlet end of the plug and Fig. 3 the edge near the outlet. The annular band apparent upon visual examination unetched was similarly apparent after etching as a difference in luster. Its depth is indicated by the final change from darkened to light portion of Figs. 2 and 3, along the line X-X. The difference in color can be more easily seen under lower magnification, as in Fig. 4. The depth of this band in each specimen is nearly the same, but the thin, whitened layer at the edge, near the outlet end is considerably shallower than that near the inlet end. The character of the change from the normal structure to that of the affected (darkened) area can be seen from Fig. 6, in which the left hand part of the photomicrograph is toward the edge of the specimen. Figs. 5 and 7 show the effect of etching with Stead's reagent, after the method of Ruder[5] for showing nitrogenized ferrite. The specimens were etched and lightly polished three times to accentuate the differences, as suggested by Comstock.[5] Fig. 7 is in the transition area, as is Fig. 6, and Fig. 5, is a low power view.

Fig. 4. Bore near outlet. 8 sec. HNO Mag. 40

Fig. 5. Bore near outlet. Stead's reagent. Mag. 40

Regarding the thin, whitened layer in Figs. 2 and 3, it should be noted that the conditions under which they

[5]Trans. A. I. M. M. E. Vol. XLVII, 1922.

were formed were not complicated by the effect of the travel of a projectile along the bore or by the effect of intermittent heating and sudden cooling. Hence it can be stated that the deeper layer was caused by either in-

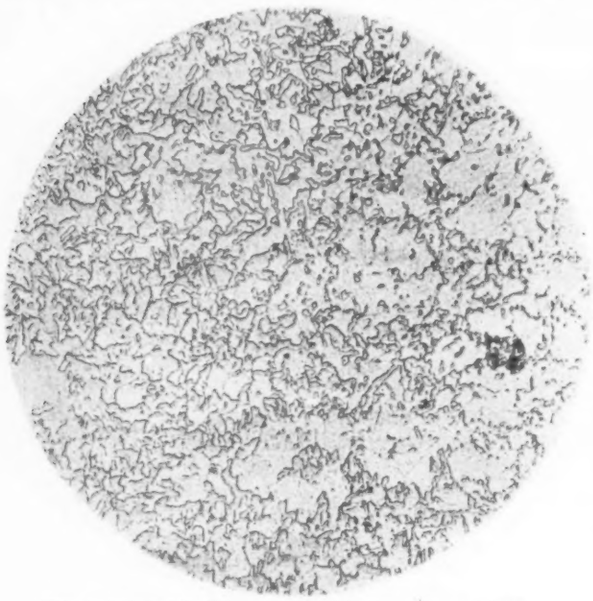


Fig. 6. Transition from normal structure. 15 sec. HNO_3.
Mag. 500

creased pressure, or temperature, or both. Others have pointed out that the white layer is harder and more brittle and by its brittleness, increases erosion by flaking off. Increased brittleness must be granted, but it is desired to suggest that the nonconcomitant characteristics—

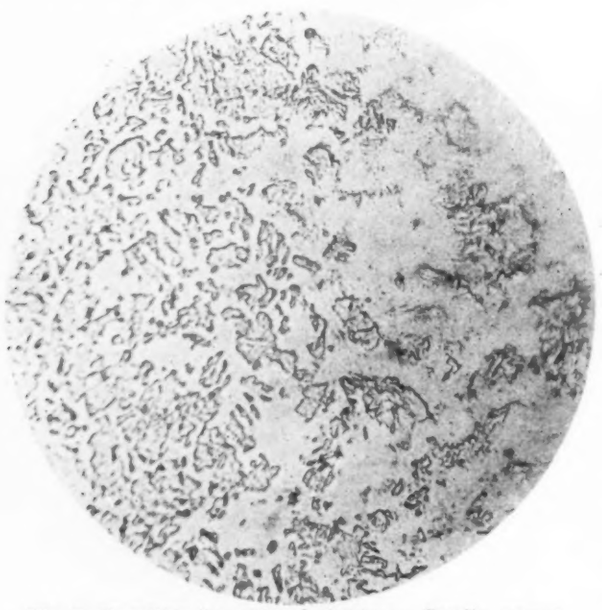


Fig. 7. Transition from normal structure. Stead's reagent.
Mag. 500

increased resistance to abrasion and probably greater strength (if the effect of increased carbon is not entirely offset by that of increased nitrogen) tend to reduce this effect. That all is not hopelessly embrittled and swept out by projectiles and gases is shown by the fact that there is always a deposit of it left when a gun bore is cut up for examination. Flaking, where it occurs, may be also ascribed to the minute network of erosion cracks leaving tiny patches of unsupported metal that would be sheared off under sudden, heavy friction loads whatever the physical characteristics of the material might be.

It will be noted that there are no erosion cracks shown in Figs. 2 and 3, such as are visible in all badly eroded gun bores. The fact that no projectile passes through the erosion plug is, of course, no factor, since erosion cracks also appear in powder chambers. In 1916, Professor Okôchi[6] called attention to the effect in guns of erratic thermal expansion and contraction of steel at the lower transformation point. Later,[7] he brilliantly developed the theory in relation to the stresses causing erosion cracks and their characteristic appearance. It is based on the fact that steel expands uniformly under the influence of heat until, on passing the Ac_1 transformation point, it suddenly contracts and continues to follow a coefficient of contraction for some time before again expanding. A thin surface layer of metal is heated in the bore of a gun upon firing, which in turn imparts heat to a second underlying layer, and so on. The temperature of the underlying layers, while this action is taking place, always lags considerably behind that of the surface layer. When the surface arrives at the Ac_1 point, it must contract and at a moment when the rest of the gun is still expanding, thus causing a rupture of the thin layer, out of step, as it were, with the rest of the metal. This contraction, forced to take place circumferentially and axially, causes the transverse and longitudinal character of the network typical of erosion cracks. The fact that the erosion plug showed no erosion cracks is not in conflict with this theory, as the heat application in this case was continuous and of comparatively long duration, making the temperature gradient less abrupt and the layers affected, plastic.

There is little need to demonstrate to those who are in close touch with ordnance, the powerful, almost annihilating effect of a thin stream of incandescent gas at high velocity and under great pressure. Fig. 8 shows the scouring action of gas leaking through a crack in the mushroom stem of a 16-inch gun during two rounds. The surfaces marked A are saw cuts made to split the stem open, exposing the path of the gas. The discharge of the primer comes from the top, along the vent which can be traced through the center. The gas escaped out the crack on either side, depositing exuded metal on the outside of the stem. On another occasion, a 14-inch gun, during the process of blowing up, squirted gas out between the mushroom pad and gas check seat, removing an annular portion of metal from the rear edge of the seat, the cross section of the ring removed being roughly an isosceles triangle with sides 0.4 inch long and 0.25 inch in height—the while sending the projectile down the range for 18,000 yards. A more familiar case of the power of single, practically instantaneous squirts of gas is the blow back that ruins gas check rings and sometimes the gas check seats.

The destructive effect of impinging gases seems to be vitally affected by the direction of flow and the velocity (as determined by clearances, given the usual pressures). Erosion plugs may serve to illustrate the relative effect of different sized openings for these gases. Several

6M. Okôchi:—Ueber die Wärmespannung im Geschützrohre. *Proc. Tokyo Math.-Phys. Soc.* Vol. VIII. No. 18, 1916.
7M. Okôchi:—On Erosion of Guns. *Jour. Col. Eng. Tokyo Imp. Univ.* Vol. IX, No. 7, 1919.

plugs were selected for firing a second and third time, the data recorded being summarized in columns 1 and 2 of Table II. The results were reported at the time as inconclusive, which is natural, inasmuch as the comparative value of the per cent loss in weight figure is lost with a difference in dimensions (the bore in this case) of the specimens. This difference in the bore also modifies the conditions of the test, there being no commensurate change in the powder charge. If this loss of weight figures is used to calculate the average diameter of the bore before and after each trial, a close approximation of the average depth of metal washed away can be obtained. Results of such a calculation are shown in column 3 of Table II. They are remarkably uniform in that they indicate successively less depth of erosion at each trial, notwithstanding the fact that variations in pressure sometimes opposed as well as sometimes favored this action. The volume of gas (amount of powder) was the same in each case and the pressures are of approximately the same order. These experiments and any calculations based on them, are inherently rough, of course, and can be regarded as indications only.

TABLE NO. II.

	1			2			3		
Plug	Max. Press.	Tons per sq. in.			Per Cent Loss in Weight		Calculated Depth of Erosion (inches)		
Marked	1st Trial	2nd Trial	3rd Trial	1st Trial	2nd Trial	3rd Trial	1st Trial	2nd Trial	3rd Trial
1 — 1	15.87	15.01	15 11	12.8	10.1	12.0	0.069	0.033	0.029
1 — 3	15.17	14.84	13.98	11.5	11.1	12.1	0.063	0.038	0.030
2 — 1	14.90	13.92	13.98	12 5	12.3	10.9	0.068	0.040	0.026
2 — 3	*	15.59	16.32	12 3	11.2	10.7	0.067	0.036	0.026
3 — 1	16 85	15.04	13.86	13 0	13.2	9.99	0.070	0.039	0.024
3 — 4	15 69	16.06	13.67	10.9	13.1	12.1	0.061	0.042	0.030

* Not recorded.

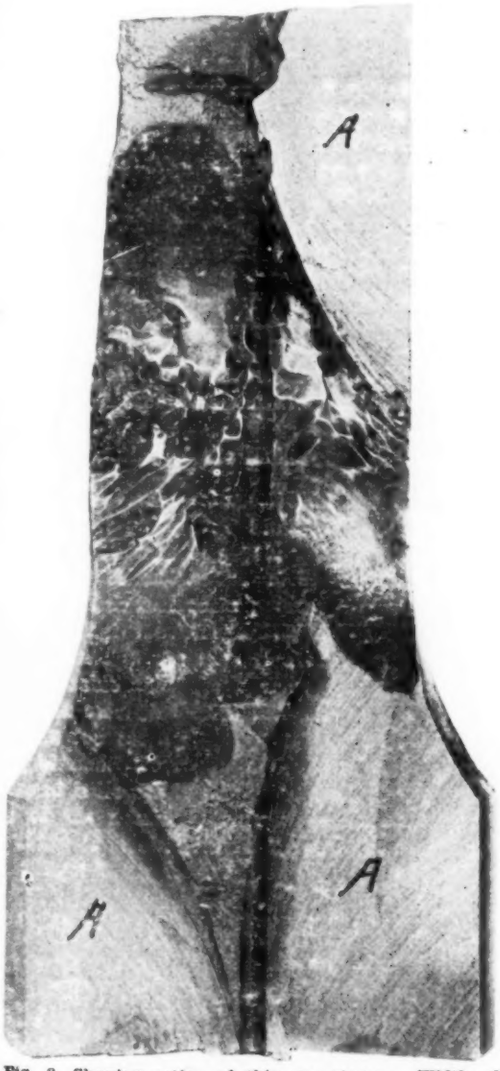


Fig. 8. Showing action of thin gas stream. Width of specimen at top 2.5 inches. Diameter of vent 0.15 inch

It should be noted in this connection that the plugs, on the second and third trials, had the white layer in the bore caused by the previous firing. That this layer is not sufficiently weak or brittle against gas erosion to reverse or nullify the results to be expected from a slightly larger bore, seems to be established.

Another incident which throws light on the effect of direction and velocity (clearance) of powder gases is somewhat similar to one noted by Captain Yarnell, U. S. N.[8] The crusher gage holders used in the erosion plug experiments are usually no more affected in these tests than when used in guns. One was drawn near the vent hole of the plug during the test and securely welded to it. This had the effect of deflecting the gases, or constricting the vent opening, or both, so that the gases tore away much more metal than in any of the other five plugs of identical metal, tested at the same time. So great was the disparity in action that the results on this plug had to be thrown out. Note the generation of intense fusing heat by velocity and impingement of the same gas that cannot, by its mere presence, raise metal to a high heat in the same length of time. In Captain Yarnell's example, the article in the gas chamber was a thin sheet metal can.

Tschernoff[9] thus describes the progress of erosion: "The first evidences of erosion are manifested in the appearance of dull spots upon the brilliant surface of the bore, principally in the upper part of the chamber, in the centering cone and cone itself at the origin of rifling." How well the locality and the effect reported coincides with what we might expect in the case of a heavy projectile not securely seated. The clearance would be at the top. The sudden development of velocity in the gas particles in this vicinity before the projectile can move would produce a selective and localized high thermal effect. Tschernoff says further: "Examination of gutta-percha impressions shows that these spots (those mentioned above) are made up of net-works of small cracks, extremely fine and very shallow." Keeping in mind this localized heating effect due to small clearances, this checks very well with Okochi's theory of the formation of erosion cracks.

It is not in the scope of this article to investigate the critical clearance which would produce the greatest erosive effect at a given pressure of heated gas. It seems obvious that the increasing effect of smaller clearances would not extend to miscroscopic cracks. Somewhere increase in velocity is halted by increased resist-

[8]Yarnell:—Jour. Soc. Naval Eng. Vol. XXII, 1910.
[9]Peloux:—The Tschernoff Theory of Erosion. Jour. U. S. Art. Vol. XLI, 1914.

ance to the passage of the gas. The leakage past a projectile may be practically nothing on one round and very considerable on another and it may well vary with the passage of the projectile down the bore. It seems certain that it cannot be uniform in any gun for any class of projectile, for the reason that the personal element of nonuniform seating of the projectile must be a factor, as well as variations of material and firing conditions.

This mention of nonuniform seating of projectiles does not refer to a variation sufficient to exert an influence on the pressure developed or the range obtained. That would be hard to accomplish, since it is understood that both the Army and the Navy have had experience with practically unseated projectiles giving satisfactory pressures and ranges. Lower pressures may, of course, sometimes be obtained under these conditions, as can be forecast by a consideration of the pressures noted in column 1 of Table II. Here it is seen that practically equal or greater pressures may be obtained with considerably larger orifices, as well as lower pressures. The 14-inch gun that failed gave a range of 18,000 yards, when only 18,800 yards would probably have been obtained had everything held tight. Apparently, if the necessary maximum pressure is developed, a considerable volume of gas can be lost without sensibly changing the magnitude of the principal events.

It is desired to emphasize that, irrespective of the effect on range, complete seating of projectiles is important primarily to reduce erosion by gas leakage. It is at the origin of rifling that erosion is always greatest. Knowledge that this gas action is erratic and, in isolated cases, nonexistent, should not becloud the fact that, for service conditions, it is a very potent factor in gun erosion. Investigation of its causes and possible cure cannot be allowed to lapse. And the intensive study of the *effects* of erosion on material should not lessen the efforts to combat erosion by eliminating or reducing gas leakage.

Author's Note:—Acknowledgment is due Mr. J. W. Talley, of the U. S. Naval Gun Factory, for his valuable and painstaking assistance in preparing specimens and photomicrographs.

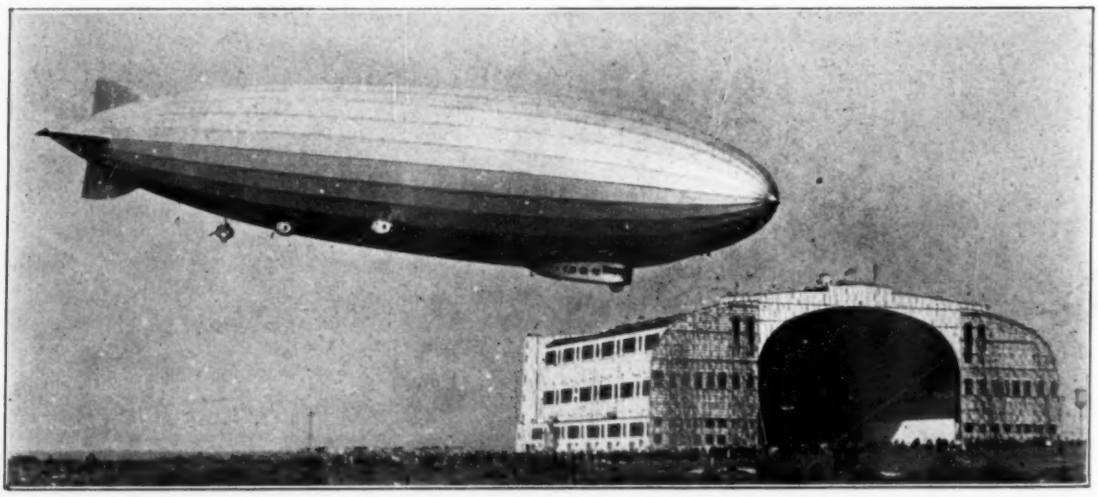
Industrialists Make Aerial Survey of Philadelphia Ordnance District

TWENTY-NINE members of the Army Advisory Board for Industrial Mobilization in the Philadelphia Ordnance District made an aerial survey of their territory from the naval airship Los Angeles May 15th. The personnel of the board includes men nationally prominent in finance, industry, science, education and military affairs. They were guests of the Secretary of Navy Wilbur on the cruise of the huge dirigible which flew from its base at Lakehurst, N. J., and cruised for six hours at an altitude of about a mile over Camden, Philadelphia, Trenton, Easton, Bethlehem, Reading and Wilmington.

Among those invited to make the aerial survey were Hon. Dwight F. Davis, Assistant Secretary of War; Hon. Benedict Crowell, President of the Army Ordnance Association and former Assistant Secretary of War; Mr. John C. Jones, Chief, Philadelphia Ordnance District, E. T. Stotesbury, W. W. Atterbury, Irenee duPont, Felix duPont, Eugene Grace, Elbridge Johnson, Leonard Kinnard, W. C. Eglin, President of the Franklin Institute; J. W. Rawle, A. C. Dinkey, Atwater Kent, George Horace Lorimer, Charles Russ Richards, President Lehigh University; Josiah Penniman, provost of the University of Pennsylvania; Brig. Gen. Dennis E. Nolan, acting Chief of Staff, U. S. A.; Maj. K. K. V. Casey, Director of the Military Sales of the E. I. duPont Company; Capt. W. E. Ditmars, Executive Assistant, Phliadelphia Ordnance District; and Graham McNamee, radio announcer station WEAF, New York.

The cruise of the Los Angeles was entirely successful and gave the members of the Board a bird's eye view of the industrial and strategic importance of the Philadelphia district. The purpose of the flight is best explained in the words of Secretary of the Navy Wilbur as follows: "This project is an important part of the army and navy preparedness program. The individuals comprising the Advisory Board are keymen in the Nation's scheme of national defense. Voluntarily they give to the Philadelphia district and to the United States services which the Government could not secure on a salary at any cost, however high.

"There is much in the functioning of emergency industrial mobilization which these men must know. Not the least is a complete visualization of the Philadelphia area, which is of great importance to the United States from a wartime industrial viewpoint."



The Los Angeles Returning to Lakehurst

Modern Small Arms and Their Manufacturing Requirements

PART II

By

GLENN P. WILHELM

(Part I of this article, "Modern Small Arms and Their Uses," was published in the March-April, 1925, issue of ARMY ORDNANCE, Vol. V, page 713)

WE WILL now take up the manufacturing requirements of the small arms problem. As stated in Part I of this article, the Ordnance Department of the Army supplies the entire Army, Navy and Marine Corps with small arms and small arms ammunition. From an engineering standpoint, the scale of production of small arms matériel is enormous. Quantity production is here seen in its greatest significance. For instance, in time of war, machine guns are produced by the hundreds of thousands, rifles by the millions, and small arms cartridges by the billions.

Take the case of gages alone, the U. S. Rifle, Caliber .30, Model of 1903 (The Springfield Rifle), requires 1,263 gages, while the Browning Machine Gun, Caliber .30, Model of 1917, requires an enormous number, 2,262 gages.

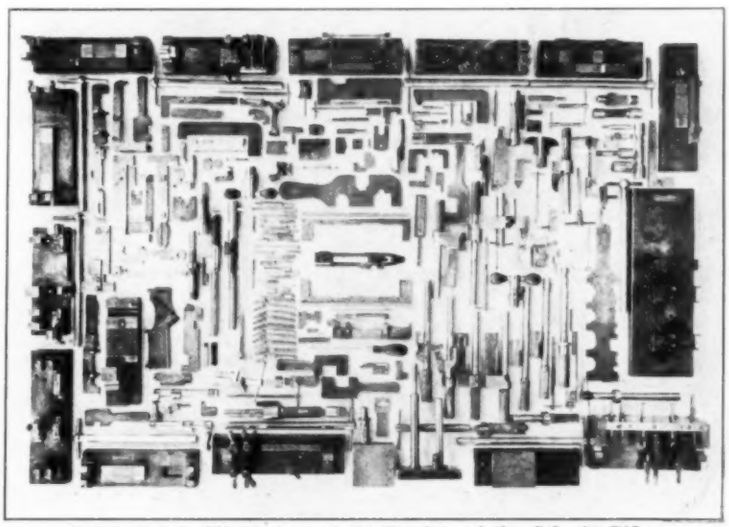
This phase of Ordnance work should be of a great deal of interest to Ordnance Reserve Officers by reason of the fact that it is possible to put, in direct application, manufacturing knowledge gained in commercial life. On the other hand, the experience gained in the manufacture of small arms is of direct benefit for engineering production in commercial engineering lines. The small arms Ordnance problem in quantity production is similar to that in the automotive industry.

War-Time Manufacturing Problems of Small Arms Ammunition

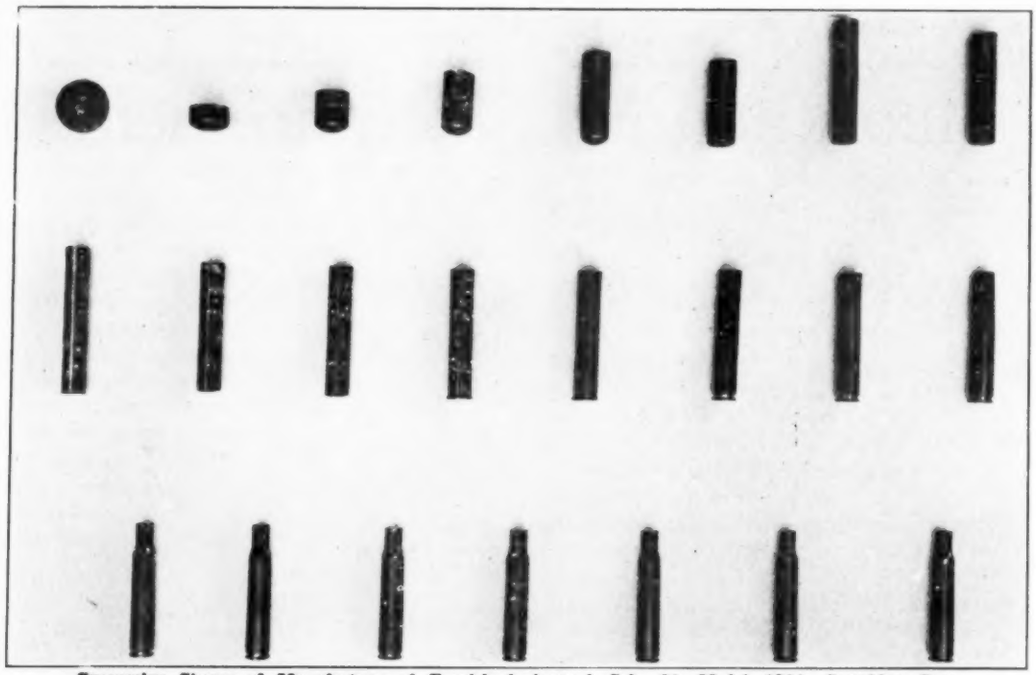
On account of the stupendous figures involved, the importance of efficient methods of manufacture in small arms and small arms ammunition cannot be minimized. For instance, in the case of the caliber .30 cartridge, the manufacture of the case alone requires engineering talent of the highest order. If the base of the case is not designed with sufficient thickness, the gun and the man firing it will be wrecked with the great pressure of 52,000 pounds per square inch which is exerted. Even though the case is correctly designed, if the annealing is too soft, it will be difficult for the rifleman in rapid fire to extract the cartridge from a hot and dirty rifle chamber. On the other hand, if it is annealed too hard, so as to give easy extraction from the rifle, it will give trouble in the machine gun after the gun is worn and has increased headspace by producing separated or ruptured cases; i. e., the base of the case will pull off, leaving the remainder in the chamber. This means temporary disability for that gun; and in the case of an aircraft gun, it means a landing before the stoppage can be remedied. During the war an attempt was made to make a case which would function well in two different types of rifle, and seven different types of machine gun. In the next war, this problem will probably be solved by making two different types of cases, which, in an emergency, can be used in either the rifle or the machine gun, but which normally operates best in the gun in which it is intended to be fired. This does not complicate supply to the extent that it might be thought, as machine gun ammunition in the next war will be loaded at the factory in ammunition belts and sealed in ammunition boxes ready to be placed on the gun.

If the neck of the caliber .30 case is too soft, bullets will easily pull out or fall out. If the neck is too hard, it will crack sooner or later and let the bullet fall out. This defect alone in Great Britain and the United States has probably accounted for the salvaging of over 1,000,000,000 rounds of ammunition at a cost of around $40,000,000.

During the war, 30,000,000 cartridges made by one company were made with the bullet jacket material too hard, so that this ammunition was inaccurate and could only be used for machine gun target practice. Its inaccuracy resulted from the jacket being too hard to properly take the rifling, hence the great waste.



Gages used in Manufacture of the Receiver of the Cal. .30 Rifle



Successive Stages of Manufacture of Frankford Arsenal Cal. .30, Model 1906, Cartridge Case

List of Operations (left to right): 1. Blank; 2. Cup; 3. 1st Draw; 4. 2nd Draw; 5. 3rd Draw; 6. Bump; 7. 4th Draw-Wash; 8. Trim and Sort; 9. 5th Draw; 10. Trim; 11. Pocket; 12. Head; 13. Vent & Pocket Size; 14. Head Turn; 15. Body Anneal; 16. 1st Taper; 17. 2nd Taper; 18. Plug; 19. Mouth Trim; 20. Inspect; 21. Insert Primer; 22. Varnish Primer; 23. Crimp Primer.

Primer Defects

During the early part of the war, a large number of cartridges were loaded with primers manufactured of inferior ingredients, and, due to lack of adequate facilities, the primers were not properly dried. The sulphur in the primers, due to action of moisture in the air, formed sulphuric acid, which in turn formed a sulphate and caused a gradual deterioration. After a few months, hangfires developed, so that when a rifleman pulled his trigger the explosion occurred after a momentary pause sufficient, in some cases, to allow him to open the bolt in rapid fire about the time the cartridge went off, thus disabling his gun, and in some cases, the rifleman.

Other Manufacturing Difficulties

There were similar manufacturing errors made with rifles and machine guns. No doubt, in the next war, there will be more errors. These examples have been quoted merely to show the difficulty that is encountered in such manufacture, and the importance of proper manufacture.

At the present time, in preparing War Plans, difficulty has been encountered in perfecting procurement plans for caliber .50 armor-piercing cores. These cores are made of 3 per cent tungsten steel, which, after machining, are given a special heat treatment. The difficulty in procuring proper tungsten steel and in machining it after it is obtained indicates that the use of a different material may be necessary.

Design and Production

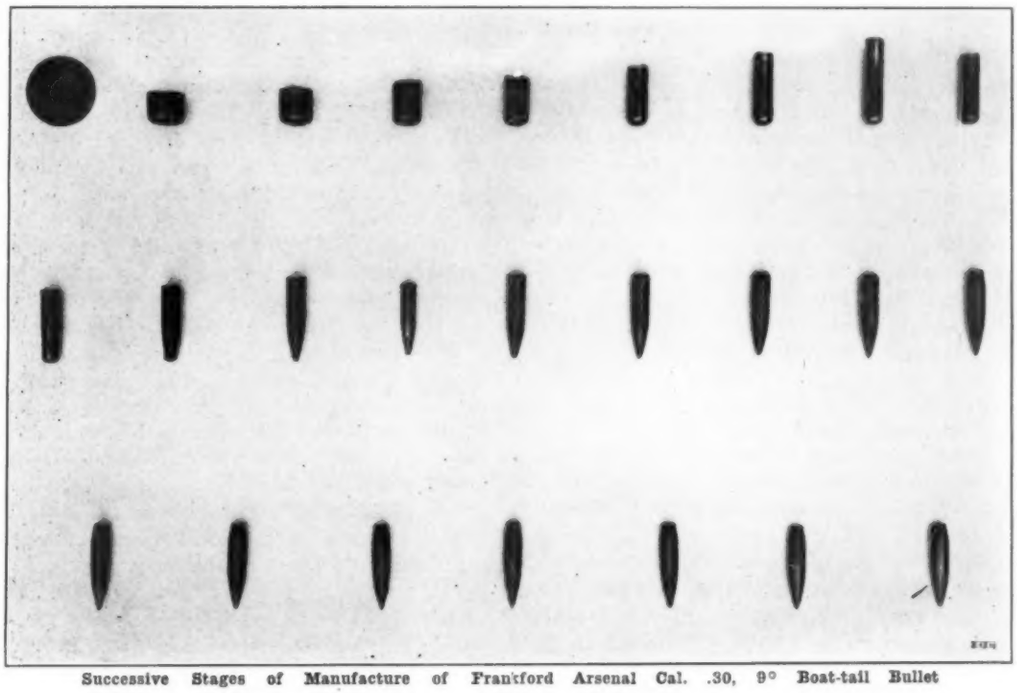
The small arms manufacturer's job is one of design and production. The designing is usually done by an inventor, and the production by the production engineer. Rarely are the two qualifications combined in one man. The ideal preparation of a correct manufacturing design should be such that the volume of production of each item which goes to make up the assembled unit is approximately equal; i. e., there will be no choke points. The neck of the bottle which chokes production should be enlarged so as to resemble the straight sides of the tube of the chemist. At present, the neck of the production bottle lies in badly determined manufacturing design of the components sought.

Importance of Interchangeability

Almost any good mechanic can make a gun which will operate. Almost any good manufacturer can produce guns in quantity. However, it is rare in gun design to obtain one which can be produced in quantity and which will satisfactorily function. The main purpose of the small arms manufacturer is not to produce merely arms, but to produce guns in quantity which will shoot. Quantity production necessitates the use of interchangeability, although interchangeability in parts is necessary from other than manufacturing reasons. Automobiles which are now made in Detroit can be bought in Africa and replacement of parts made in New Zealand. This, however, is not nearly as desirable as it is for a machine gun made in Hartford to operate with parts made in Bridgeport and to receive replacement parts in France which were made at Rock Island. The question of supply in the field and the functioning of the weapon in the hands of troops require interchangeability just as much as do manufacturing requirements.

Origin of Interchangeability

Interchangeable manufacture was originally developed by the manufacture of small arms. For instance, there was patented in 1811, the first interchangeable product ever manufactured in quantity; i. e., the



Successive Stages of Manufacture of Frankford Arsenal Cal. .30, 9° Boat-tail Bullet

List of operations (left to right): 1. Blank; 2. Cup; 3. 1st Draw; 4. 2nd Draw; 5. 3rd Draw; 6. 4th Draw; 7. 5th Draw; 8. 6th Draw; 9. 1st Trim; 10. 1st Point; 11. 2nd Point; 12. 3rd Point; 13. Form Lead Core; 14. Insert Slug; 15. 1st Cone; 16. 2nd Cone; 17. Size; 18. 1st Boat-tail; 19. Cone; 20. Flatten Base; 21. 2nd Boat-tail; 22. 3rd Boat-tail; 23. 4th Boat-tail; 24. 5th Boat-tail; 25. Final Size.

Hall breech-loading rifle, 25,000 having been made for the U. S. Army by 1842, all of which were interchangeable.

Before this there were several instances of interchangeability. Eli Whitney of cotton gin fame undoubtedly originated the idea in so far as public recognition is concerned. The War Department in 1798 gave him an order for muskets which were to be on a "new principle"; i. e., "interchangeability." Almost equal credit should be given Simeon North, the pistol manufacturer, who was a contemporary of Whitney's, and who, in an order for pistols given to him in 1799, later incorporated interchangeable features. The first instance, however, of quantity production on a huge scale was in 1877 when an American company at Bridgeport made 600,000 Peabody Martini breech-loading rifles for the Turkish troops for use in the Russo-Turkish War. This contract represented the successful development of the peculiar American theory of manufacture upon the interchangeable plan.

*Interchangeability and Its Relation to Tolerances and Allowances

"Interchangeability is merely a matter of tolerances and dimensions. A tolerance may be defined as a zone within which the desired surface must wholly lie. The adapted limits abound this zone. Dimensions specify the plane, cylinder, sphere, cone, etc., forming the boundaries of the tolerance zone." The difference between a tolerance and an allowance is evident if an allowance is defined as "the minimum clearance between mating surfaces" in a moving fit and in a tight or forced fit as "the largest amount of interference in the metal necessary to produce the tightness desired."

It is indeed fortunate that the manufacturing equipment best adapted for mass production is also the best means of securing interchangeability of components. The investigation of interchangeability in tolerances is an exacting task. The time to do this investigating, however, is at the time the weapon is being designed, otherwise the pilot model may be completed, may function beautifully and yet be absolutely impossible to manufacture without changes by reason of the impracticability of making the parts involved to the necessary tolerances and limits. When changes are made in the model, in order to meet manufacturing requirements, the model is found to function no longer. In any case, the manufacture of a model which has been designed without adequate study of tolerances and allowances will invariably result in expensive manufacturing operations.

Interchangeability does not necessarily imply economical and efficient manufacture. Pilot models may function well in themselves and their parts may readily interchange from one to the other, yet actually manufacture in quantity may be impossible because of accumulated variations and impossible tolerances. Even when tolerances are obtainable, they do not always produce interchangeability. Guessing at tolerances and rule of thumb methods are very tedious, costly and inconclusive. The only way to avoid this is by incorporating in the original design the adoption of attainable tolerances with limits adjusted to secure interchangeability.

"The adoption of attainable tolerances and the correct analysis of their effects under all conditions is the crux of interchangeable manufacturing and mass production. An attempt should be made to adhere as closely as functional conditions will permit to the larger range of ob-

*Author's Note: The writer acknowledges his indebtedness for much of the following discussion to the article in *Mechanical Engineering*, December, 1924, on "The Design of Ordnance Matériel" by J. D. Pedersen. Mr. Pedersen, who is one of the foremost inventors, designers and production engineers of the country on small arms is at present engaged on ordnance design at the Springfield Armory.

tainable tolerances. In analysis, the simple male and female engagements may be solved first; then the surfaces entering only into limited functional trains, and lastly, the surfaces entering into all the functional trains for that component. As the tolerances of each involved surface adds to the final variation accumulated through a functional train, it is generally desirable to shorten these trains as much as possible in the design."

One of the problems of manufacture which pertains more or less exclusively to small arms is that the designer of firearms must confine his operating parts to a very small space, as he is faced with lack of room. Tolerances should be such so that necessary clearance between parts becomes as definite a function as the required operative contact. In small arms the demands of the exterior shape of the weapon result in a permitted space being almost entirely filled with components. Despite lack of room, and, in addition to performing many other functions, the mechanism must sustain and operate under forces, in some cases, as great as 60,000 pounds.

"A mechanism of this class may contain from 100 to 300 component parts, all but one or two of which are of steel, frequently alloy or high carbon steel. The components are machined from forgings or from the solid bar, and many of them receive heat treatment. There are no unmachined surfaces. In the Infantry rifle about 1,500 distinct operations, 700 of them being machining operations, are required for various components. The machine gun requires several hundred distinct machining operations. To control each machining operation, one or more limit working gages is necessary. A similar set of gages bearing the adapted limits should be used to inspect every machine operation on substantially every component. Many surfaces are formed by second or finishing operations.

"The majority of machining operations consists of milling, next drilling and reaming, profiling, slotting, shaving, boring, turning, grinding, and screw machine operations are frequent.

"To maintain the factory discipline necessary to secure interchangeability and easy mass production, all work must be rigidly inspected. Any component not entirely within its gage limits should be rejected. The tolerances adopted for each operation, therefore, must be readily attainable with the equipment when operated by the class of workmen available during war time production. Such tolerances only will permit the fair rejection of any work which may be outside its gage limits."

Machinery and Tool Equipment

With regard to the use of machinery and tool equipment, method of gaging and inspection, the procedure of small arms manufacture closely follows commercial practice. In this respect, to a certain extent, small arms differ from the manufacture of other items of Ordnance matériel, such as artillery and artillery ammunition.

When machine shops are set up, full consideration is given to the production requirements. Machinery layouts are made up with a view to routing work from machine to machine and through the shops to eliminate loss of time and motion. Piece work is commonly practiced and tariffs are set to conform as nearly as possible to piece work rates established in commercial plants for like work.

The different classes of machines which are used are of standard types. Special tools, forgings, dies and tool-holding fixtures are necessary to the same extent as is common to production manufacture, either commercial or military. However, the machines are standard as are drillers, lathes, millers, grinders and drop hammers. In the case of firearms, the gun barrel requires the use of special rifling and drilling machines.

To insure the use of more standard machines than otherwise it is considered good practice in Ordnance small arms engineering to incorporate in the final design of each component, such adaptation to facilitate locating the component in a standard machining fixture. "With few exceptions, the best location is obtained by a plane locating surface on the component. Two holes of ample size and of accurate spacing and diameter should be carried in normal to the locating surface. If the component does not functionally require such a plane surface and holes, these locating points should be introduced upon it for machining purposes. The objectional portions of the locating points can be removed by a final operation if necessary."

It is of interest here to note that the reduced caliber semiautomatic rifle hereinbefore referred to as being designed by Mr. Pedersen incorporates in the original design the desirable features so necessary to quantity production, including facilities for locating components in fixtures for machining purposes. This weapon should, therefore, be easy to produce in quantity. In this case the inventor happens also to be a production engineer.

Class of Labor

The class of labor required in small arms manufacture need not be special, and is similar to that of commercial companies, since the use of standard machinery is so common. Automatic machinery is used to a large extent, which does not call for the skill of the trained machinist. Women are often employed to a large extent. For instance, at the Eddystone Plant of the Baldwin Locomotive Works, during the World War, a large proportion of the workers were women, and it was found that they could do very satisfactory work. This plant was probably the largest plant in the United States which was engaged in manufacturing rifles exclusively.

Small Arms and Gages

In conclusion, the rôle of gages in the production of small arms will be brifly discussed. Gages are an essential part of quantity production. It is possible, under certain exceptional conditions, to produce efficient weapons in quantity without the proper use of the modern gaging system. Such plants as the Springfield Armory in the pre-war days were able to turn out fine rifles by "conscientious care and competent supervision in spite of defects in the gaging system."

However, American manufacturers were entirely unsuccessful in the World War when they attempted to get in quantity production on the British Enfield rifle with an inadequate solution of the gage problem. This was true under the favorable conditions they were operating as "peace prevailed here; labor, both skilled and unskilled, was plentiful" and the companies represented the best in America in strength and capital.

OLD AND NEW TYPES OF SMALL ARMS AMMUNITION.

ITEM	Weight of Complete Round	Weight of Bullet	Weight of Case and Primer	Weight of Powder Charge	Muzzle Velocity	Maximum Chamber Pressure	Maximum Horizontal Range	Maximum Vertical Range	Effective Horizontal Range	Effective Vertical Range	Penetration at 50 Yards	Length of Daylight Visage of Trace	Muzzle Striking Energy	Maximum Penetration in Armor of A.P. Amm.	Elevation for Maximum Range	Mean Radius at 600 & 1000 Yards	Kind of Powder	Type of Bullet
Cartridge, Ball, Caliber .30, Model of 1906 (Present Service.)	400 gr.	150 gr.	196 gr.	50 gr.	2700 f. s.	Lbs., sq.in. 52,000	3450 yds.	2700 yds.	2500 yds.	1500 yds.	½″ Mild Steel		2400 ft. lb.		30° +	5.19″ (r) 9.65″ (r)	Pyro D.G.	Cup. Nick. Flat Base
Cartridge, Ball, Caliber .30, Model of 1924 (New Service).	418	171.5	195.5	50	2700	52,000	6000	4700	5000	3500	½″ Mild Steel		2800		32°	2.26″ (m) 5.685″ (m)	Army Lot 1489 or eq. of Du Pont 1147	Gilding Metal 9° Boat-tail
Cartridge, Armor-Piercing, Caliber .30, Model of 1922.	415	168	195.5	50	2700	52,000	3500	1800	500 As A. P.	500 As A. P.	.6″ Class A Armor		2750	.6″ Class A Armor	30° ±	5″	Pyro D.G.	
Cartridge, Ball, Cal. .22, Long Rifle, Gallery Prac. (Com. Std.).	54	40	11 ±	3 ±	1050	8–10,000	1350	1100	200		At 50′ 7 ⅜″ Pine Boards		112		35° ±		Lesmoke	
Cartridge, Gallery Practice, Caliber .30, Model of 1919.	346	140	195.5	10.5	1100 at 53′	15,000	Approx. 2000	1500	300 ±								Du Pont No. 80	
Cartridge, Incendiary, Cal. .30, M1918 (Components only on hand).	395.5	150	195.5	50	2700	52,000	2000	1500	300 For Incend.	300 For Incend.		600 yds.				12″ ±	Pyro D.G.	
Cartridge, Tracer, Caliber .30, Model of 1924, Green.	410	152	195.5	46.5	2650	46,000	1500	1500	1000	1000		1100				10″ ±	Army Lot 1489 or Equivalent of Du Pont 1147 (2% Tin)	
Cartridge, Tracer, Aircraft, Caliber .30, Model of 1923.	410	152	195.5	47	2700	45,000	1500	1500	800	800		800				10″ ±		
Cartridge, Tracer, Caliber .30, Model of 1924, Red.	410	152	195.5	46.5	2650	46,000	1500	1500	1000	1000		1100				10″ ±		
Cartridge, Ball, Pistol, Caliber .45, Model of 1911.	323.6	230	89	5	800	16,000	1500		75		8⅞″ Pine Boards		360				Bull's eye or Pistol Powder	
Cartridge, Armor-Piercing, Caliber .50, Model of 1923.	1898	812	851	235	2500	52,000	9000	7000	7500	5000	Thru 1″ Armor		11300	1″	30° ±	5″ ±	Nitrocellulose Powder with 2% Tin incorporated	
Cartridge, Ball, Caliber .50, Model of 1923.	1898	812	851	235	2500	52,000	9000	7000	7500	5000			11300		30° ±	5″ ±		
Cartridge, Caliber .30, National Match 1919.	400	150	196	50	2700	52,000	3450	2700	2500	1500	½″ Mild Steel		2400		30° +	5.19″ (r) 9.65″ (r)	Pyro D.G.	Cup. Nic. Flat Base
Cartridge, Caliber .30, National Match 1920.	416	170	195.5	46.8 Pyro 50.1 IMR 17.5	2550 At 78′	52,000	3600									4.74″ (r) 10.24″ (r)	Pyro D.G. I.M.R. 17.5	Cup. Nic. Flat Base
Cartridge, Caliber .30, National Match 1921.	416	170	195.5	48.2	2700	52,000	3600									2.57″ (m) 8.42″ (m)	Du Pont 1076	Cup. Nic. Tinned Flat Base
Cartridge, Caliber .30, National Match 1922.	416	170	195.5	45.4	2700	52,000	4500									3.18″ (m) 7.22″ (m)	Hi Vel	Gilding Metal 6° Boat-tail
Cartridge, Caliber .30, National Match 1923.	416	170	195.5	45.5	2650 At 78′	52,000	4500									2.850″(m) 6.662″(m)	Hi Vel	Gilding Metal 6° Boat-tail
Cartridge, Caliber .30, National Match 1924.	417	171.5	195.5	47	2701 At 78′	52,000	6000–									2.26″ (m) 5.685″(m)	Hi Vel	Gilding Metal 9° Boat-tail
Cartridge, Caliber .30, National Match 1925.	423.7	172	195.5	53.2	2700 At 78′	52,000	6000–	4700	5000	3500			2800		32°	2.30″ (m) 5.710″(m)	Du Pont No. 1489	Gilding Metal 9° Boat-tail

(r) Fired in National Match Rifles. (m) Fired in Mann Rest.

When the United States entered the War, the only thing that made it possible for us to equip our men with American-made rifles was the fact that we utilized the gages and other equipment created for the purpose of meeting Great Britain's needs. As it was, the majority of our machine gun units was forced to fight with foreign machine guns, such as the Hotchkiss, because our own superior weapon, the Browning, required such a long time to reach quantity production by reason of the lack of gages. This delay occurred after the pilot models of the gun had been designed, manufactured and tested. Where huge quantities of weapons must be produced, adequate gaging is a most necessary part of the manufacturing requirement.

Comparison of Developed Horse Power of Various Types of Small Arms and Commercial Types of Engines.

SMALL ARMS

Weapon	Weight	Rate of Fire Per Minute	Ft. Lbs. Per Shot	H. P.	Lbs. H. P.
Service Rifle	8.69 (1)	30	2800	2.54	3.42
Semi-Automatic Rifle	10.0 (2)	60	2800	5.08	1.96
Automatic Rifle	15.5	550	2800	46.7	0.33
Machine Rifle	18.5	550	2800	46.7	0.39
Aircraft Machine Gun, Cal. .30	24.5	1200	2800	101.6	0.24
Aircraft Machine Gun, Cal. .50	55.0	600	11300	203.2	0.271

(1) With oiler and thong case. (2) Estimated.

ENGINES

Motor	Weight	R. P. M.	H. P.	Lbs.—H. P.
Aircraft, Original Wright	191.8	1200	25	7.67
Aircraft, Liberty "12"	851.0	1700	400	2.13
Aircraft, Curtis OX-5	445.0	1400	90	4.94
Aircraft, Hispano-Suiza	432.0	1400	150	2.87
Aircraft, Wright MT-3	1160.0	2000	640	1.81
Aircraft, Packard M-1A-744	541.8	1600	185	2.93
Aircraft, Packard M-1A-1116	733.0	1600	260	2.82
Automobile, Dort, 4 Cyl.	318.0	1900	33	9.63
Automobile, Cadillac, 8 Cyl.	830.0	2200	70	11.85
Gas Engine, Nash	2600	360	8	325
Tractor, Holt, 4 Cyl.	1200	1400	55	21.80
Tractor, Wisconsin, 4 Cyl.	680.0	1600	55	12.4
Tank, M and T	2500.0	1600	220	11.35
Steam Locomotive, Sante Fe Type	612000 (1)	60*	13280	46.2
Diesel Engine, Marine (Nobel)	340000	105	1440	236

(1) Total Engine and Tender. *Miles per hour.

The Ordnance Enlisted Specialist

ENLISTMENT for the Ordnance Department presents to the recruit a wide choice of vocational endeavor, with opportunities for development and advancement limited only by the soldier's ambition and determination to progress.

Upon completion and acceptance, all Ordnance material intended for the use of troops becomes a responsibility of Ordnance Field Service. This division stores, issues, inspects, preserves, maintains, alters and repairs the material during its useful life in the military service. The Field Service is essentially military in character. Its service is directly to, and with, the line of the Army.

Its functions properly are performed by military personnel, and to it are assigned control and administration of a greater part of the enlisted personnel of the Ordnance Department.

The duties of Field Service group themselves about certain major functions. The receipt, storage, issue, and inspection and preservation in storage, of items of general supply fall naturally together, and these duties are performed by personnel of the Ordnance Company (Depot). Repair, alteration, and maintenance of general supply items, and the inspection of matériel in the hands of troops are carried on by personnel of the Ordnance Company (Maintenance). Storage, inspection, preservation, maintenance and issue of ammunition belong to the Ordnance Company (Ammunition).

Certain other Ordnance organizations are formed for specialized work. The Ordnance Company (Headquarters) carries on the details of Army Ordnance control of general supply, ammunition supply, and maintenance, and supplies administrative service to certain schools and training centers. The Ordnance Company (Proving Ground) supplies operating personnel for proving grounds of the Technical Staff and the Manufacturing Service. Ordnance Companies (Training), furnish the instructor specialists required for the Schools, Training Centers, Replacement Centers, etc. of the Ordnance Department.

At Raritan Arsenal, N. J., near New York City, is located the Ordnance Specialists' School, an establishment primarily for the instruction and training of enlisted specialists for the Ordnance Department.

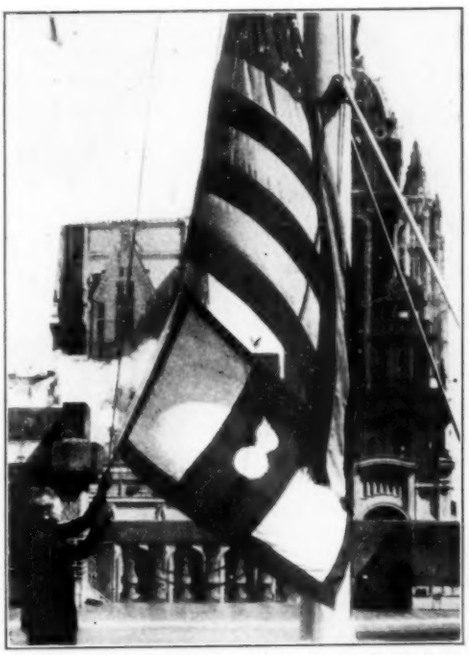
Enlisted men, who give evidence of aptitude, and who have the necessary physical and service qualifications, can make application for detail to the School as students in the regular courses. The entrance exmaination is not severe; the educational requirements are not beyond men of ordinary grammar school attainments. For men who are basically qualified for detail to the courses, but who lack the necessary degree of education to complete them, the School maintains an academic department which develops the required proficiency as the vocational instruction progresses.

New York Ordnance Reserve Plants Designated

Tentative Orders Allocated by Ordnance District Advisory Board

ONE hundred and forty manufacturers, representing many of the largest war-time producers of ordnance in the vicinity of New York, met at the Harvard Club in New York City, April 3rd, in conference with the New York Ordnance Advisory Board, of which Judge Elbert H. Gary is Chairman, to receive allocations of "tentative orders" for the production of ordnance matériel which the New York District will be called upon to produce in the event of war. The orders included all types of ordnance supplies ranging from components for the largest calibered artillery to small arms, rifles, machine guns and ammunition. Upon acceptance of these orders by the companies designated they will be known as "ordnance reserve plants," and will assume a status similar to that of ordnance reserve officers as now provided by law for individuals who volunteer their services for national defense.

Besides Judge Gary, Chairman of the United States Steel Corporation, the Ordnance Advisory Board includes P. E. Crowley, President, New York Central Lines; John I. Downey, President, John I. Downey, Inc.; M. Friedsam, President, B. Altman & Company; S. Parker Gilbert, Agent General of Reparations in Germany; General James G. Harboard, President, Radio Corporation of America; Herbert P. Howell, Vice-President, Peierls, Buhler & Co., Inc.; Samuel McRoberts, Chairman, Chatham-Phoenix National Bank & Trust Co.; Charles M. Schwab, Chairman, Bethlehem Steel Corporation; Guy E. Tripp, Chairman, Westinghouse Electric & Manufacturing Company; William H. Woodin, President, American Car & Foundry Co., and Colonel James L. Walsh, Chief of the New York Ordnance District, member ex-officio.



Raising the Ordnance Flag, Atop U. S. Steel Corporation Bldg., New York City

Opening Remarks by Judge Gary

Judge Gary, who presided at the meeting in his capacity as Chairman of the Ordnance Advisory Board, welcomed the manufacturers who were present and pointed out that their attendance in such large numbers constituted an impressive response to the call of duty. Continuing, he said: "We should bear in mind that, with the exception of one Regular Army Officer who spends most of his time on this work, all of the other Government representatives with whom you are establishing contact are serving voluntarily—without pay—and I think we should remember that progress in our plans is very largely measured by the amount of time reserve officers can spare from their regular business pursuits.

"We are facing a tremendous problem. During the World War it was estimated that it would cost some thirteen billions of dollars to equip our first five million men with the arms and ammunition required to put them on an equal basis with the enemy. It is apparent that a considerable portion of this sum would have been saved by proper planning before the declaration of war. We have tried to take this lesson to heart, and we are now planning to meet this emergency, if one should unfortunately occur in the future.

"I believe in the fundamental soundness of the War Department's plans, and there is in my mind absolutely no question that these plans bear every evidence of a sincere attempt to take up the matters in hand in an orderly manner and on an equitable basis which is intended to insure—as far as is humanly possible—a square deal for the manufacturer and the prompt supply of highest quality munitions for the Government.

"During the past year, the members of the Advisory Board have had ample opportunity to familiarize themselves with the War Department's plans for the mobilization of Industry for purposes of National Defense, and I think I may say that, if these plans are promptly carried to completion, the United States will be more nearly impregnable than ever before in our history. Industry has nothing to gain through war and everything to lose. Our greatest desire is for continued peace, and we are glad to help the War Department in its endeavor to insure it.

"Even if war is never again thrust upon us, it will be possible to reduce appropriations for reserve stocks of war material in direct proportion as we are able to acquire the ability to get into production when needed."

Comment by General Tripp

General Tripp, in addressing the meeting, said in part, "This getting together of the War Department and manufacturers makes possible the doing of good work for the Nation under the best possible conditions, instead of forcing the turning out of bad work under the worst possible conditions. Especially it eliminates, as far as such a thing can be done, the fly-by-night manufacturers who upset markets, cornered supplies, preempted labor, clogged transportation, did poor work, and were the real profiteers during the late war.

"The best feature of today's demonstration is," continued General Tripp, "that it does not constitute a challenge to any foreign nation. The only possible reply that even the most aggressive of our foreign neighbors can make to it is to initiate similar systems themselves. To this we would not have the slightest objection. We could see in it no danger to ourselves and would freely concede that it is not only their right, but their duty, to take such effective defense measures."

Colonel Goodrich Describes Ordnance Requirements

Another speaker was C. C. Goodrich, of the B. F. Goodrich Rubber Company, who is a Colonel in the Officers Reserve Corps and Chief of Manufacture in the New York Ordnance District.

"Some idea of the size of this undertaking may be had," said Col. Goodrich, "by considering that at the present time there are about one quarter of a billion dollars' worth of ordnance allocations in the New York district, consisting for the greater part of ammunition. In addition, the item of fire control instruments alone calls for the expenditure of $20,000,000.

"One concrete problem before us now is that of furnishing 15,000,000 .30 and .50 caliber tungsten steel cores per month. This means that this one job would keep 550 screw-machines running continually day and night, 25 days a month."

Speech by New York District Chief

Col. James L. Walsh, Chief of the New York Ordnance District on a dollar-a-year basis, cited official figures which showed that, in proportion to the population, the United States maintains the smallest standing army of any of the fifty principal countries of the world—our ratio of 124 soldiers per hundred thousand of population, being actually less than the 164 soldiers per hundred thousand which Germany is allowed to maintain under the terms of the Armistice—notwithstanding that it was thereby intended to render Germany impotent as a military power. Continuing, Colonel Walsh said: "We are the wealthiest nation in the world—due largely to the sacrifices of those who have gone before us—yet we maintain but four soldiers per ten millions of national wealth, while Great Britain maintains forty, France seventy-three, Italy eighty-three and Japan one hundred and eleven soldiers per ten millions of national wealth.

"Since the war, we have built up two wonderful institutions in the Organized Reserves and the Reserve Officers Training Corps. Within the area covered by the New York and Buffalo Ordnance Districts, there are 78 officers of the Regular Army assigned to the instruction of the Organized Reserves, and 53 Regular Officers assigned to the instruction of the Reserve Officers Training Corps, or a total of 131 Regular Officers devoting their full time to problems related to man power and training in the use of arms. On the other hand, there are but 3 Regular Army Officers who give their whole attention to problems connected with the manufacture of arms.

"Economy is the watchword of the day, and rightly so. It is doubtless impracticable to augment the Regular Ordnance Department either as to personnel or as to funds, but as it stands now, unless the manufacturers of this district, and the Reserve Officers who represent the government without pay, apply themselves wholeheartedly to the solution of the problems in hand, the whole program of National Defense will be critically out of balance.

"During the past year, one hundred and fifty Reserve Ordnance Officers have been recruited, assigned to specific duties in the District Organization, and have received elementary training at a course of lectures sponsored by the Advisory Board. On Defense Day, a District Office was set up completely equipped with office furniture, telephone and telegraph service, etc.—all through the courtesy of various public spirited corporations and without expense to the government. The District Organization is gradually shaking down into a fairly well-knit outfit, reasonably competent to represent the interests of the government in the important negotiations now about to be inaugurated. With further efforts toward mutual education and continued co-operation on the part of manufacturers over the next three or four years, we may yet be able to say that the ordnance problem—the crux of preparedness—is well in hand."

General Summerall's Address

Maj. Gen. Charles P. Summerall, Commanding General, Second Corps Area, and one of the foremost figures of the American Expeditionary Forces, was the next speaker at the meeting. General Summerall's address follows:

"The anniversary that this evening commemorates has a significance that dominates our thoughts. We recall the dramatic appearance of the President before the joint houses of Congress, at night, and his solemn message that plunged the country into war. From its status of neglect and toleration, the Army became suddenly the hope of the people. Only a few years have passed since a peace was made, and again the old prejudices are revived. The Army is again neglected and it is constantly threatened with still further reduction.

"It is easy to forget. In the public clamor against the maintenance of our armed forces it is well for us to think of some of the things that they have done for our government and that they still mean for its stability. We hear much of the cost of war and the burden of taxation to meet the expense of former wars and to maintain the Army of today. The reaction upon the public mind is to condemn the profession of arms and to seek to reduce or to suppress the Army. War is denounced as an iniquitous thing and the Army is regarded as an unproductive superfluity under the existing scheme of civilization. Such views can not be supported by the history of this Republic. Even before the Revolution, the Colonies created a militia for the defense of their people. The thought of war had already forced itself upon them, but, nevertheless, they wished sincerely to be loyal to the mother land. Washington spoke the wish of the people when he said concerning independence in 1774, "I am well satisfied that no such thing is desired by any thinking man in all North America; on the contrary, that it is the ardent wish of the warmest advocate for liberty that peace and tranquility upon constitutional grounds may be restored and the horrors of civil discord

prevented." Yet Washington at the same time was speaking the conviction of the whole people when he incorporated in the resolutions of Fairfax County the significent words, "From our sovereign there can be but one appeal."

"In the tragedies that followed, war was the only recourse of an oppressed people. There was no crime in it as we are told is the case today. Our armies fought to win an honorable existence for the people and to secure peace. Besides these blessings they gained the territory of the Colonies and their resources for the inhabitants and for their posterity. The cost in money amounted to four hundred and eleven millions of dollars but the material value of the territory set free was incalculably greater.

"Again, when our country's sovereignty was challenged in 1812, the cost in money amounted to one hundred and twenty-seven millions of dollars, but the gain was the maintenance of its independence as well as the possession of its territory.

"Recently it was my privilege to traverse the Great Southwest and to stand on the battlefields of Palo Alto and Resaca de la Palma. History tells of the call to arms to protect the Texas border in 1846, and as a result of the war, the addition to our government of the territory comprising the States of New Mexico, Arizona, Colorado, Nevada, Utah, Wyoming and California. The cost of this war and of the Gadsden Purchase was fifty-nine millions of dollars. Contrasted with this amount is the annual production from the developed resources of these States, including Texas, which exceed two billions of dollars. Their actual value cannot even be estimated. Yet our country entered upon this war to protect our rightful territory and in recognition of a state of war created by a neighboring state.

"Of Lincoln it can be said that his patriotism has never been excelled and his love for his fellow man has never been equalled. His great heart yearned over the land, and war was farthest from his purposes and thoughts. At his first inaugural address he said: 'To the extent of my ability I shall take care, as the Constitution itself expressly enjoins upon me, that the laws of the Union be faithfully executed in all the States. * * * In doing this there needs be no bloodshed or violence; and there shall be none, unless it be forced upon the national authority.' Yet within a few weeks he was compelled to issue a proclamation calling forth the armed forces to suppress combinations in the Southern States, 'too powerful to be suppressed by the ordinary course of judicial proceedings.' If the calamitous Civil War cost seven billions of dollars it saved not only the Union but the vast territory the intrinsic value of which is too great by comparison to be reckoned.

"On April 25, 1898, the Congress stated in a resolution that 'War has existed since the 21st day of April * * * between the United States of America and the Kingdom of Spain.' Again one of our most peace-loving presidents was forced to recognize a war that was farthest from our wishes and for which we had no preparation. It cost two hundred and nineteen millions of dollars but it resulted in the vindication of our national honor. It added to our economic life the production of territory whose value amounts to billions of dollars.

"There is no greater paradox in our history than our entry into the World War. Utterly unprepared we regarded ourselves as bystanders. Our neutrality was impressed by every means upon the people, who were enjoined to be neutral in thought and in deed. We were represented as too proud to fight over the violation of our rights under international law. We suffered abuse from both sides yet no steps were taken to strengthen our armed forces. A Secretary of War who advocated moderate defensive legislation was removed from the Cabinet. The sincerity of the President to preserve peace was profound and he was reelected upon the slogan 'He kept us out of war.' Yet within a few weeks after his inauguration he addressed a message to Congress reciting the acts of war that were committed by one of the belligerents and that compelled the country to defend its honor. Almost in despair he ended by exclaiming, 'The day has come when America is privileged to spend her blood and her men for the principles that gave her birth and happiness and the peace which she has treasured. God helping her she can do no other.' The cost of that terrible struggle has been more than twenty billions of dollars, but the account shows a vastly greater material gain. It is seen in the prosperity of the people who have more money per capita than any other nation. It is seen in the balance of trade which has amounted to many billions as a result of the war, and it is seen in every element that constitutes the nation's wealth.

"It was not only in war but in our ability to make war that territory has been acquired. When Spain closed the Mississippi River to our navigation for two hundred and seventy-five miles, Congress adopted warlike measures and the Louisiana Purchase resulted. Jackson's conquest of Florida was adjusted by its purchase. The graves of American soldiers on San Juan Island are mute evidences that our Government was prepared to stand by its compromise on the forty-ninth parallel when it receded from its rightful claims to the line of 'fifty-four, forty' for the Northwest boundary. It said in effect: 'Thus far we go and no further.'

"Today our territory has an estimated value of more than three hundred and twenty billions of dollars and every part of it has been possessed through war or the power to make war. If material returns alone are considered, war has been the most profitable activity in which the country has ever engaged.

"But our Army has never fought except to restore peace when the agencies for preserving peace have failed. The cost of our military operations have been, therefore, not the cost of war but the price of peace. Because our Army has never known ultimate defeat, the country has never known the real cost of war. This has ever been the collapse of government, the loss of territory, and the payment of overwhelming idemnities. Thanks to the valor of our armed forces the nation has been spared such calamities.

"It is unworthy and ungrateful for the people to consider the money expended on our Army in the past and at the present as a reason for rendering the nation defenseless. The resolution approved April 6, 1917, ends with these significant words, 'And to bring the conflict to a successful termination, all the resources of the country are hereby pledged by the Congress of the United States.' These resources were material and human. Of the material cost, much is said, but one hears too little of the real sacrifices in life, in mental and physical suffering of our soldiers and of our people in all of our wars.

"The soldier more than any other man desires peace, for he alone knows the horrors of war, and, in the last

analysis, he must suffer most from its consequences. At the same time he knows the price of peace, and he has never hesitated to pay it in personal sacrifice. The profession of arms is still honorable and necessary. Until the country can devise some effective means to adjust international disputes and internal strife, it will be courting destruction to undermine the military spirit of the people and to enfeeble the armed forces."

The New York Ordnance District received from the Chief of Ordnance, Washington, specific allocations of large quantity ordnance requirements, and it was felt that the manufacturers would be better prepared to discuss the designations after having inspected samples, drawings and specifications covering these materials which were on exhibition during the meeting.

To a casual "looker in," this meeting at the Harvard Club brought back the hustling days of 1917 and 1918. The room was filled with serious faced men going over drawings and specifications with army officials and making changes in the plans and their factories to meet the Government requirements, as to equipment, personnel, and transportation. These changes will enable the manufacturers to begin the execution of their contracts in time of war with the least possible loss of time. These plans, when completed as agreed upon by the manufacturers and Government officials will be kept and filed so that they may be reviewed annually or whenever necessary.

Industrialists Present

In addition to Judge E. H. Gary, representing the United States Steel Corporation, and General Tripp, representing the Westinghouse Electric and Manufacturing Company, there were present:

Fred J. Gauntlett, Washington Representative, Aluminum Company of America;
Jos. B. Terbell, President, American Brake Shoe & Foundry Co.;
J. A. Thompson, American Brake Shoe & Foundry Co.;
Colonel H. F. Dalton, American Car & Foundry Co.;
Philip C. Osterman, Vice President, American Gas Furnace Co.;
Chas. A. Schults, Engineer, American Gas Furnace Co.;
Major Wilfred J. Hawkins, Vice President, American Machine & Foundry Co.;
Stephen S. Tuthill, Secretary, American Zinc Institute, Inc.;
Edward V. Peters, American Zinc Institute, Inc.;
Lorenzo H. Pike, Asst. Treas. & Secy., Brass Goods Manufacturing Co.;
Wm. S. Weeks, Secretary, Calco Chemical Co.;
Nelson B. Gateh, Asst. to Vice Pres. Sales, Chicago Pneumatic Tool Co.;
H. R. Segoine, President, Cronk Manufacturing Co.;
R. A. Lufburrow, Vice President, Cronk Manufacturing Co.;
J. H. Dunning, President, J. H. Dunning Corporation;
E. B. Strange, Vice President, J. H. Dunning Corporation;
Daniel T. Haggerty, Asst. to Chairman, Board of Directors, T. A. Edison Industries;
J. W. Schatz, President, Federal Bearings Co., Inc.;
H. H. Barnes, Jr., General Electric Company;
Francis D. Jackson, President, Hecla Iron Works;
Fred W. Smith, Hecla Iron Works;
R. E. Anderson, Hoe & Company, Inc.;
G. G. Knox, Hoe & Company, Inc.;
A. C. Judd, President, Huhn Manufacturing Co;
J. F. Boreland, Vice President, Huhn Manufacturing Co.;
Charles V. Barrington, Vice President, Jenkins Brothers;
William H. Utz, Director, Jenkins Brothers;
William G. Le Compte, Director, Jenkins Brothers;
Arthur A. Kraeuter, President, Kraeuter & Company, Inc.;
L. H. Buttenheim, Vice President, McKiernan-Terry Drill Co.;
T. E. Sturtevant, Chief Engineer, McKiernan-Terry Drill Co.;
A. Van Hassel, Vice President, Magor Car Corporation;
R. E. Cartzdafner, Magor Car Corporation;
J. M. Davis, President, Manning, Maxwell & Moore, Inc.;
Henry D. Carlton, Vice President, Manning, Maxwell & Moore, Inc.;
Eugene M. Moore, Vice President, Manning, Maxwell & Moore, Inc.;
Frank J. Baumas, Vice President, Manning, Maxwell & Moore, Inc.
Stephen J. Meeker, Secretary, Meeker Foundry Company;
Walter B. Mehl, President, Mehl Machine Tool & Die Co;
Charles P. Worth, Mehl Machine Tool & Die Co.;
Philip T. Dodge, President, Mergenthaler Linotype Co.;
John C. Cotter, Merrill Brothers;
Norman C. Newman, President, I. C. Newman Company, Inc.;
Ed. L. Leeds, Niles-Bement-Pond Co.;
A. C. Smith, Otis Elevator Company;
Henry S. Otto, Vice President, Albert T. Ott & Sons;
N. S. Reeder, Vice President, Pressed Steel Car Co.;
A. S. Henry, Vice President, Railway Steel-Spring Co.;
Benjamin L. Winchell, Chairman & President, Remington Typewriter Co.;
A. A. Forrest, Vice President, Remington Typewriter Co.;
H. Shapiro, President, Shapiro Bros.;
J. Shapiro, Shapiro Brothers;
W. F. Dixon, Works Manager, Singer Manufacturing Co.;
J. C. Mattern, Asst. Superintendent, Singer Manufacturing Co.;
John V. Rice, Jr., President, Sloan & Chace Mfg. Co. (succeeded by Rice Machine Tool);
Otto Webber, Sloan & Chace Mfg. Co. (succeeded by Rice Machine Tool);
Two representatives, Snead & Company;
E. C. Atwood, Underwood Typewriter Co.;
Ed. J. Bingle, President, Unexcelled Mfg. Company, Inc.;
Thomas Jardine, Secretary, Unexcelled Mfg. Co., Inc.;
T. H. Markillie, Director of Sales, United Lead Company;
E. A. Stillman, President, Watson-Stillman Co.;
L. R. T. Brown, Works Manager, Watson-Stillman Co.;
David L. Luke, President, West Virginia Pulp & Paper Co.;
Geo. R. Wadleigh, West Virginia Pulp & Paper Co;
C. P. Coleman, President, Worthington Pump & Mach. Corp.;
William Goodman, Vice President, Worthington Pump & Mach. Corp.

Frankford Arsenal Ammunition Wins National Match Tests

By

R. V. REYNOLDS

(This article is a reprint of "Frankford Uber Alles," *The American Rifleman*, May 1, 1925)

IN a neck and neck race, as full of thrills and powder fumes as the finish of the National Team Match, Frankford Arsenal outdistanced Remington, Western, and Winchester, and won both events in the test for selecting Palma Match and International Match ammunition for 1925. Victory was sweet to Frankford, for it marked the culmination of two decades of effort on the part of the Government ammunition makers to surpass the special match cartridges of their commercial rivals. Their congratulations were honestly earned, for in the long range contest they beat Remington-Palma, which the majority of riflemen concede to be the most uniformly accurate match cartridge the world has ever known.

The cartridge which accomplished this feat contains a high velocity charge of du Pont progressive-burning nitrocellulose, behind the Arsenal's 172 grain, 9 degree boat-tail, gilding metal bullet. This assembly of components is thoroughly modern. It is the same as those which will probably be adopted within the next few months as the service ammunition for the United States Army. They are also the same as those which won the test for National Match ammunition last fall, which showed accuracy little inferior to the best Palma ammunition known at that time. The winning Palma cartridge is therefore the hand-loaded big brother of the 1925 National Match load, and of our probable future service cartridge.

The bullet used in the winning Palma, and in 1925 National Match ammunition, is also used in the winner of the Iternational Match test. This bullet has the flattest trajectory and longest range of any bullet ever tested by the Ordnance Department. It gives a trajectory up to a thousand yards which is only about two-thirds as high as that of the 150-grain, flat base service bullet, and requires ten minutes less elevation. The extreme range is nearly double that of the service bullet.

At a meeting held in Washington, October 14, 1924, the Board for Determining the Type of Arms and Ammunition for the National and International Matches for 1925 decided to test International and Palma Match ammunition at the Ordnance Proving Ground, Aberdeen, Maryland, on April 6. On March 24 the date of this test was postponed until April 23 and 24.

The conditions were laid down approximately as follows:

1. All firing to be conducted from Mann barrels, at the Small Arms Testing Range.
2. Not to exceed two lots to be tested at each distance for each contestant.
3. For International Match ammunition, firing to be at 300 meters, and 15* targets made the first day.
4. For Palma Match ammunition, firing to be at 1,000 yards, and 20* targets made the first day.
5. Firing on the second day to be a repetition of the first day's program.
6. Measurements and averages to be made as in other recent tests, the Palma winner to be the ammunition showing the smallest mean radius, and the International load to be that showing the best figure of merit.
7. Limit of acceptable chamber pressure to be 52,000 pounds as determined by the Board, with uncompressed coppers.

* Revised program called for 12 International and 16 Palma targets each day.

Descriptions of Competing Ammunition

	COMPETITORS AND LOTS			BULLETS			POWDER			MEAN VEL.	PRESSURES			
				Grains	Shape	Jacket	Grains	Make	Lot	At 78'	Mean	Factory Max.	Coppers and Initial Compression	Board Mean Pressures Coppers Uncompressed
INTERNATIONAL 300 METERS	Frankf'd Ars.	Lot	1	172	9° B.T.	Gilding	36.3	Dupont	1195-5 Flake Nitro	2207	No Record			30,375
		Lot	2	172	9° B.T.	Gilding	37.6	HiVel	No. 2 Lot 1488	2199	No Record			29,545
	Remington	Lot	3	180	Flat Base	Cupro	44.5	HiVel	No. 71 Blended	2603	54,580	56,000	Uncompressed	47,137
		Lot	4	180	Flat Base	Cupro	51.7	Dupont	1147 Blended	2630	50,840	53,100	Uncompressed	50,245
	Western C Co.	Lot	1	220	Flat Base Soft Pt.	Lubaloy	50.5	Dupont	I.M.R. 15½	2313	44,640	47,290	W.R.A. Co. 42,000	47,875
		Lot	2	220	Flat Base Soft Pt.	Lubaloy	51.0	Hercules	560-9B Pyro	2375	49,320	51,070	W.R.A. Co. 42,000	50,950
	Winch'r RA.Co.	Lot	301	178	9° B.T.	Gilding	37.5	Dupont	1195 Lot 14	2227	No Record			46,383
		Lot	302	178	9° B.T.	Gilding	35.5	HiVel	Lot No. 71	2187	No Record			28,915
PALMA 1,000 YARDS	Frankf'd Ars.	Lot	3	172	9° B.T.	Gilding	54.5	Dupont	I.M.R. 1147 Army Lot 1489	2776	53,555	54,850	I.C. 45,000	52,385
	Remington	Lot	4	172	9° B.T.	Gilding	41.4	HiVel	No. 2 Lot 71	2500	40,910	41,750	Uncompressed	38,530
		Lot	1	200	Flat Base	Cupro	42.0	HiVel	No. 71 Blended	2415	51,320	52,900	Uncompressed	46,900
		Lot	2	180	Flat Base	Cupro	44.5	HiVel	No. 71 Blended	2603	54,580	56,000	Uncompressed	45,168
	Western C. Co.	Lot	3	180	Flat Base	Lubaloy	46.0	HiVel	No. 71	2642	53,940	54,670	I.C. 42,000 W.R.A.	50,110
		Lot	4	180	Flat Base	Lubaloy	51.2	Hercules	560-9B Pyro	2611	45,660	46,890	I.C. 42,000	46,625
	Winch'r RA.Co.	Lot	101	172	9° B.T.	Gilding	47.0	HiVel	Lot No. 71	2751	52,950	54,400		49,695

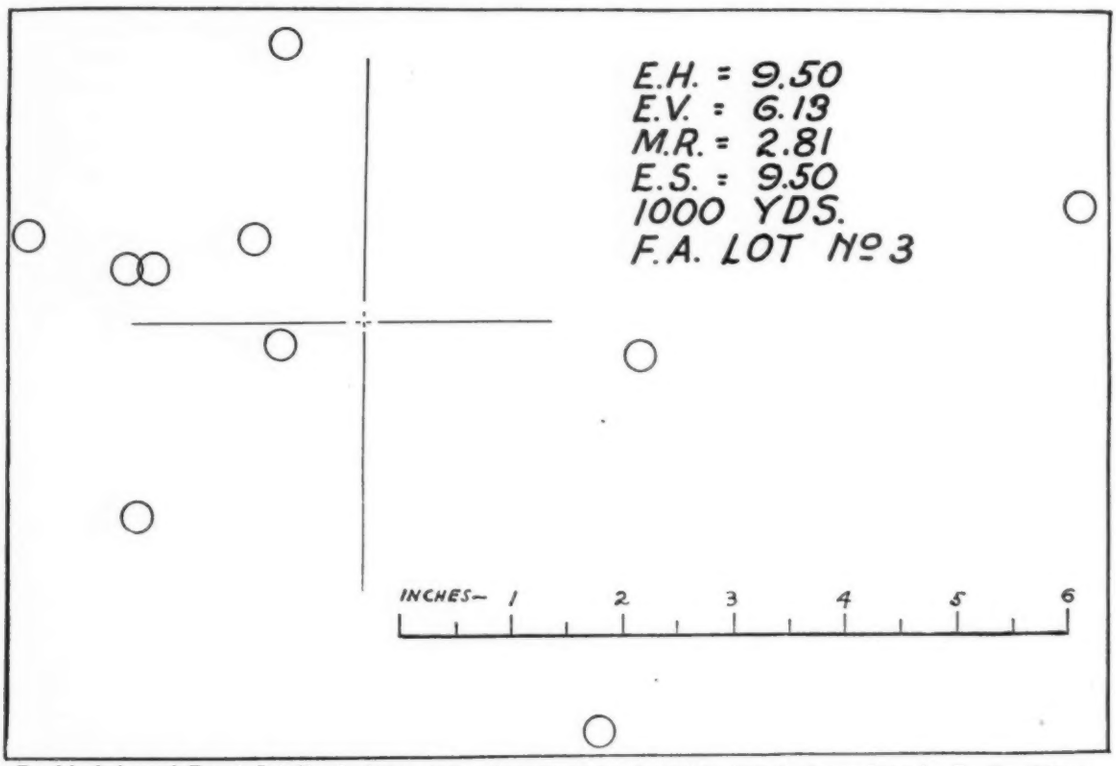
These members of the Board were present, the Senior Member, Brig. Gen. Colden L'H. Ruggles, being in Europe; Lieut. Col. George C. Shaw, Infantry; Lieut. Col. Fred M. Waterbury, N. G. N. Y.; Maj. William S. Fulton, Coast Artillery; Maj. Herbert O'Leary, Ordnance; Maj. Glenn P. Wilhelm, Ordnance; Maj. Littleton W. T. Waller, Jr., late U. S. M. C.; Lieut. Comdr. E. E. Wilson, U. S. Navy; Capt. Grosvenor L. Wotkyns, Ordnance; Mr. R. V. Reynolds, Mr. K. K. V. Casey.

Representatives of the cartridge and explosive trade were, *Frankford Arsenal,* Col. O. C. Horney, Major Hatcher, Captain Chavin, Lieutenants Rothbrock, Lewis, Schnaebel, Schnerring, Hallowell, Matthews, Wilson, Hogue; *Remington,* Messrs. Kahrs, Dickerman, Hadley, Wurme, Archambo; *Western,* Messrs. Riggs, Rosseau, Storms, Transue; *Winchester,* Messrs. Graveley, Robinson, Bollensanger; *Peters,* Col. Tewes and Mr. Starkweather; *United States,* Col. Dooley; *du Pont,* Major Simmons, Messrs. Gruendyke, Coxe, Haff, Bates; *Hercules,* Messrs. Marsh, Weldon, Troxler.

Other distinguished observers were General J. O. Joyes, Chief of Technical Staff and Assistant Chief of Ordnance, Col. W. T. Tschappat, Colonel Macnab, Brig. Gen. Phillips, Mr. Gray, Mr. F. J. Jervey, Captain Rasbach, Ordnance, N. G., N. Y., Lieut. Frazee, Laurence Nuesslein, and Harry Pope, the veteran rifle maker.

Some of the brethren are sure to be interested in the range itself, and methods of conducting the tests, so here are the principal points of interest.

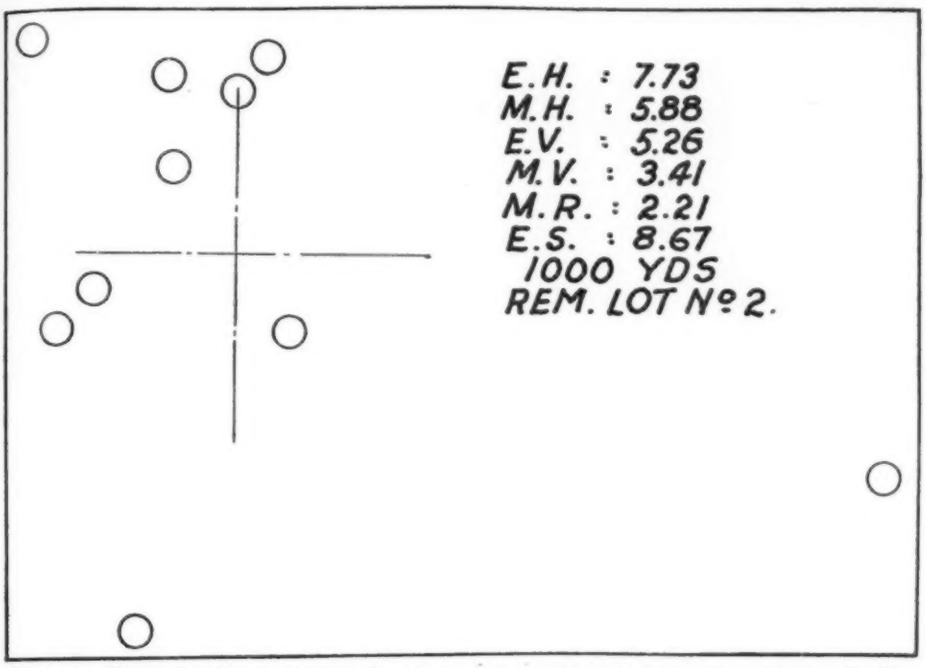
The thousand yard small arms testing range at Aberdeen occupies only a very small corner of the extensive reservation, which contains a bewildering array of quarters, workshops, artillery and bombs of all descriptions, hangars, planes, a dirigible balloon, and other paraphernalia of the Army Air Service. It is, however, a complete affair, facing approximately south. The principal firing point is a wooden building elevated several feet above ground. Five concrete pillars founded on bed rock come up through its floors, but are freed from them so that vibrations from walking do not affect the machine rests mounted on the pillars. The muzzles of the guns project through suitable windows, and command butts at 300, 600, and 1,000 yards. The 300 meter firing point is located further south and has no house, but is provided with concrete pillars, which are protected by a tent when firing is done. From this point fire is directed at the 600 yard butts. Excellent telephone connections are provided.



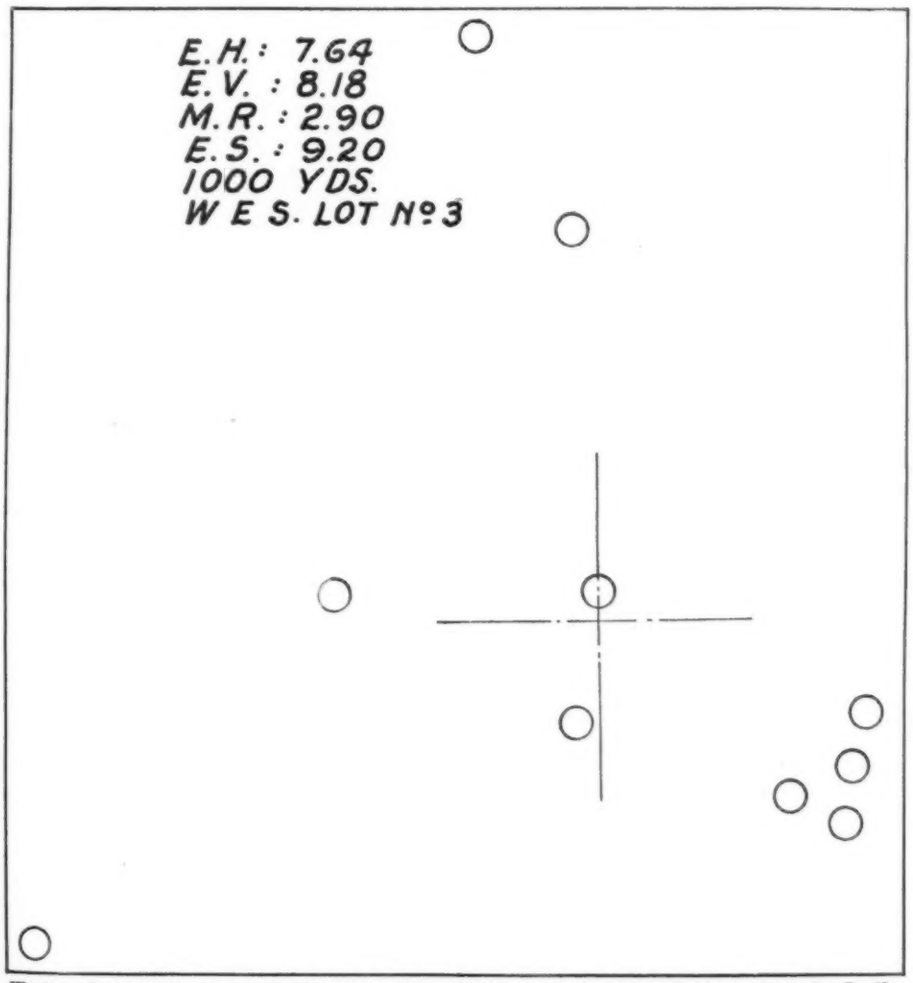
Frankford Arsenal Target Lot No. 3, 1000 yards. Approximately One-third Actual Size. Legend: E. H., Extreme Horizontal; E. V., Extreme Vertical; M. R., Mean Radius; E. S., Extreme Spread.

The concrete pillars are so equipped that firing can be done from them either with Mann barrels or service rifles. Pistol ammunition can be tested from the main firing house using special Mann barrels, and firing on target frames at 50 yards. Mann barrels, named for the late Dr. Mann, are heavy steel cylinders, about two inches in diameter and two feet long, rifled and chambered, and fitted with Springfield actions, the stocks sawed off at the neck. Each barrel carries two substantial steel collars, carefully turned and polished, one around the muzzle and the other around the chambered end.

On the top of each concrete pillar is a heavy block of steel with a raised central part, containing an accurately planed V-shaped groove longer than the barrel, and directed toward the butts. In this true, polished groove the collars of the barrels rest in firing. The groove is kept oiled to permit smooth recoil, and the gun is prevented from rearing up either by holding it down with the hand or by the use of a spring clamp applied near the middle. The mechanism is provided with



Remington Target Lot No. 2, 1000 yards. Approximately One-third Actual Size. Legend: E. H., Extreme Horizontal; M. H., Mean Horizontal; E. V., Extreme Vertical; M. V., Mean Vertical; M. R., Mean Radius; E. S., Extreme Spread.



Western Target Lot No. 3, 1,000 yards. Approximately One-third Actual Size. Legend: E. H., Extreme Horizontal; E. V., Extreme Vertical; M. R., Mean Radius; E. S., Extreme Spread.

traversing and elevating screws, by which the fire from the gun can be accurately centered on the distant target.

In firing the gun is revolved in the groove until the action is right side up. The bolt is opened and a cartridge inserted. Then the gun is slid forward until the rear collar touches a certain mark, rolled over until the trigger is uppermost, and fired by squeezing the trigger and the rear part of the trigger guard between forefinger and thumb. The object of all this is to fire a series of shots, each held, aimed and fired as perfectly as possible, without introducing any of the errors which enter into firing from the shoulder. In other words it is a test of the ammunition, with the human element removed so far as possible.

In order to remove other variables in testing several kinds of ammunition, each company's cartridges are fired from each barrel and also from each rest, an equal number of targets being made by each ammunition with each combination. By this plan each competitor has the same opportunity as every other as near as it is humanly possible to eliminate chances for advantage.

The firing is done in volleys at ten second intervals at the command of the officer in charge. Thus each ten shot group requires 100 seconds. Chances in the weather conditions are equalized because all contestants fire at the same instant.

After firing a prescribed number of targets from the same rest and with the same barrel, the competitors exchange barrels and the rests according to plan. At the same time in the butts the targets are removed and

brought to the measuring room near the main firing point. The fouled and heated barrels are thoroughly doped with metal fouling solution, scrubbed, and cooled in water.

Thus, when the firing proceeds, each contestant receives a clean, cool barrel, which contains none of the metal fouling from his predecessor's ammunition. This is deemed important because gilding metal bullets do not seem to behave as well in a barrel fouled by cupronickel jackets, and vice versa. When a contestant receives a cleaned barrel and moves to a new pillar he has to start in with sighting shots, and often if the wind is troublesome quite a little time is expended in getting all the groups safely centered at the butts. But this must be done, because at long range the effect of the wind is considerable, and if even one shot goes off the paper, its relation to the group cannot be measured, and its absence necessitates throwing out all the competing targets fired at the same time.

The butts are slightly different from those ordinarily used in target practice. Instead of having frames in which targets slide up and down, there is a tall framework which carries five big rolls of wrapping paper supported in journals, to unroll as desired.

The rolls are at the top, laid horizontally, and protected from stray bullets by sloping armor plate. At the bottom of the frames, behind the concrete butts, are five sets of journals which receive iron spools, one under each roll. The end of the paper is pulled down and a few turns taken round the spool at the bottom. This exposes part of the paper 5 feet wide and about 6 feet high, to the firing point. After a ten shot group has registered, the paper is rolled further down by turning the bottom spool, thus exposing a fresh target surface. In this way any desired number of groups may be conveniently received and rolled in compact form. Each group is marked with letters and figures of a code showing the officer in charge, which contestant, lot, gun, and firing point delivered it. These details, except the last, are not known in the butts. When the interval for changing guns occurs the paper is cut off and the loaded spools are delivered to a motor messenger who takes them by a side road to the measuring house. Empty spools are inserted, the paper attached, and firing is resumed when the contestants are ready.

In the 1,000 yard butts, standing near the telephone, one can plainly hear the volley, something like rapping on a table with a pencil. About a second later the bullets come creaking overhead and through the paper. Half a second later the reports of the guns arrive by the regular route through the air. The cracking sound of the bullets parting the air overhead is somewhat louder than a .22 rifle fired several feet away. The boat-tail bullets have a different sound from the flat base bullets, the former giving a sharper crack, on account of their greater remaining velocity at long distance. It was not until high velocity small bore ammunition was adopted that bullets made this peculiar cracking sound, and it was not always correctly explained. Even that keen observer, Colonel Roosevelt, states in his book on the Rough Riders that he and Colonel Wood heard this sound in Cuba when the Spaniards fired upon them with Mausers, and wondered whether explosive bullets were being used.

Arrived in the measuring room, the target strips are unrolled, the groups cut apart, and several crews of computers take them in hand, first to locate the center of impact, and then to measure and tabulate the extreme vertical, extreme horizontal, mean radius, and the figure of merit, which is a quantity computed from the measured factors. All of these, when checked, are posted on a large tabulation sheet, with their averages as the test progresses.

So much for the *modus operandi*. About the only unsatisfactory thing in its working is the width of the paper used for targets. At 1,000 yards under certain weather conditions it is very difficult to keep the groups well centered on a strip five feet wide, as riflemen will readily appreciate.

Considering the frequent need for sighting shots it seems possible that time might be saved if the heads of the traverse and elevation screws on the mounts were graduated to minutes.

Fair indeed to the eyes of Northern visitors were the green lawns of Aberdeen on the morning of April 23. A light southerly breeze was drifting a thin mist in from Chesapeake Bay, but the temperature was high enough to make overcoats unnecessary, and the sun promised to break through a slightly overcast sky.

On account of a drenching downpour of rain about five o'clock the Board did not assemble promptly at 8 o'clock, as scheduled. There is always some delay in organizing the personnel and getting the guns accurately laid on the 1,000 yard targets. Captain Wotkyns was in the butts, with Sergeant Rieker and four men, one to handle each target for the four competitors.

In the firing house there was a pleasurable flurry of anticipation. A test of this kind involves a great deal of expense to the competitors. If you had to pay an entry fee of several thousand dollars to fire in the Wimbledon you might fancy the responsibility felt by the men who are chosen to handle these guns. There have been months of preliminary work. The equipment is strange and a lot of strangers are looking on. The nerves are apt to be taut. Yet the veteran Hogue, of Frankford, was laying his gun to all appearances as placid a sthough he were about to try out a new brand of .22's in his cellar. Remington had entrusted its fortunes to the skill of Archambo. Transue fired for Western and Bollensanger for Winchester. Considerable time was consumed in sighting shots.

At 10 o'clock the first volleys came from the Mann barrels. The sky had brightened considerably, and the breeze from the butts to the guns had stiffened into a tricky wind, fishtailing from 11 o'clock to 1 o'clock. As the result, by 10:30 every competitor except Frankford had slipped a group partly off the edge of his target strip. At 11:45 a sudden puff took all four off the paper. Some went off at one "order" (group) of firing, and some at another, and the net result was the invalidating of six "orders" for all competitors. This situation began to loom up as a dilemma for the Board, because neither Western nor Winchester had sufficient ammunition to fire additional orders to make up the total number called for by the program.

The Board retired into executive session and considered several plans, none of which seemed to promise a solution that would satisfy all contestants.

A buffet luncheon of sandwiches and coffee helped to stimulate the flow of discussion and thought. At 2 o'clock the Board, after another protracted session, announced that it would discard all orders containing

misses, and obtain a temporary average based on the remainder, further action to depend on apparent needs after firing on the second day.

At 3 o'clock the International test began, from the tent-sheltered pillars on the 300 meter range. At this range the wind presents no difficulty so far as staying on the target is concerned, so all twelve orders were successfully completed in reasonable time and tabulated before 5:30.

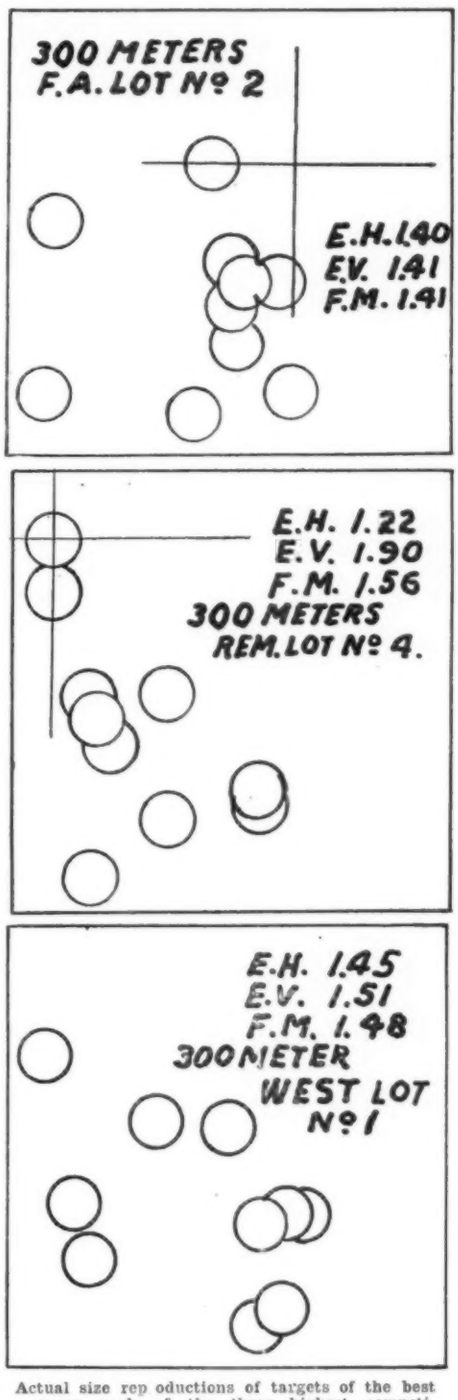
At the end of the first day of firing the figures at command showed Frankford Lot 3, and Remington Lot 2, nearly tied in the long range competition, and the other two contestants already out of the race unless a remarkable improvement should occur during the second day of test.

April 24 dawned bright and much warmer, with just a trace of bay mist in the upper air. Sighting shots began at 8:15 on the long range, in a five mile breeze from nine o'clock. The silvery form of the dirigible TC5 cruised about the reservation, occasionally approaching the range, half a mile above the cracking bullets.

At 8:30 firing of orders began, and continued without untoward incident. After 9 o'clock the breeze freshened, and became more puffy. During the day it may have been a 15 mile wind at times, but it continued squarely across the range at most times, and no bullet failed to find the five foot paper.

During the morning Major Casey, assisted by Mr. Nuesslein and Mr. Pope, sallied forth to a suitable location and fired ten rounds from each lot of ammunition in a rifle fitted with mechanism for recording chamber pressure. Briefly, the pressure blows a round piece out of the side of the case and drives a plunger against a small cylinder of copper. The copper is of known density and length. By measuring with the micrometer the reduction in length which occurs, a basis is secured for reading the pressure from a table. The high quality of the Frankford cartridge cases was apparently seen during this test. In most instances the holes in the cases were punched cleanly by the explosion, but many of the Frankford cases showed holes with ragged edges, indicating superior toughness of the metal.

At noon came more sandwiches, and a wide variety of bottled pop, served by the canteen from the tail board of a motor truck.



Actual size reproductions of targets of the best group each of the three highest competitors fired over the 300-meter range.

The short range test began soon after luncheon, and was finished with workmanlike dispatch.

Meanwhile the Board had resumed its deliberations over the problem of obtaining long range averages which would serve to pick the winner on a basis satisfactory to all contestants. Several plans were proposed and discarded. The final approved plan was worked out on a combination of the ideas of several members.

To recount here, in detail, the entire line of reasoning would be of little benefit or interest. Sufficient to say, that the main steps were:

1. Elimination of Western and Winchester on the basis of 26 sets of comparable targets from both days' firings. (See Table 2.)

2. The decision that a virtual tie existed between Remington and the Arsenal, on the basis of 31 ten-shot targets from each, the difference in mean radius being .006-inch in favor of Remington. This decision was the more necessary in view of the fact that Remington Lot 2, and Frankford Lot 3 were fired in different relays and therefore not exactly at the same time, and also, while each competitor had one target eliminated, the Frankford target eliminated had a 9 shot group, while the Remington target contained 2 shots.

3. In view of this situation, the decision to have the two leading competitors fire 16 additional targets, and to base the award upon the results shown by the grand average of 47 targets

Accordingly Captain Wotkyns dashed back to the 1,000 yard butts, and 160 more volleys rang out from the firing house. When the final series came in they were carefully measured, tabulated, and checked, and all previous figures were rechecked. Observers milled about in front of the tabulations as they do at Perry when the National Team Match returns come in by relays. When the last average was written, it showed that on the basis of 47 targets Frankford had won by .14-inch on the mean radius. Colonel Shaw announced the decision as Chairman of the Board.

Frankford Arsenal's second lot of Palma ammunition in 31 targets had a mean radius of less than five inches, and was therefore far superior to any previous winner of Palma ammunition, as the best previous record was last year's Remington-Palma, which had a mean radius of 5.50 inches.

To complete Frankford's victory the Board announced what had been obvious for some time, that in the International race Frankford was first with its Lot No. 2, and Remington second with its Lot No. 4. Third place was taken by Western Lot No. 1.

Thus ended the hardest fought contest that has ever occurred between rival precision cartridges.

With the high degree of precision now attained in match ammunition the margin of superiority shown by winners amounts to only one or two tenths of an inch on the mean radius. A more sensitive index, showing wider margins would no doubt be desirable, but none has yet been devised more satisfactory than the Ordnance system of measurements and averages.

While the winning loads will consistently keep the majority of all shots of all groups within the vertical dimension of the twenty inch V ring at 1,000 yards, or the four inch ten ring at 300 meters, there will occasionally be a shot outside these limits. It may be too much to expect that any loads will ever show the marvelous regularity required to give groups never exceeding these rings in height. Yet so many groups do so that there is room for hope that under perfect weather conditions such results will eventually be obtained.

Frankford did not win by virtue of powder, for the winning Palma load was du Pont 1147, while the International winner was loaded with Hercules Hivel. The runner-up reversed this condition, using Hivel in his long range cartridge, and No. 1147 at 300 meters.

It would seem more probable that this was a victory of bullets, for the nine degree boat-tail projectile of the Arsenal won at each range and with each powder, over the slightly heavier flat base bullet used by Remington.

The short range load of the Arsenal won by a more decisive margin in the averaged figures than was the case in the contest at 1,000 yards. International team men will have a load of wonderful grouping quality, little affected by wind and with a very light recoil. The latter factor is one of no little moment in their long grueling matches.

So far as the size of the 1,000 yard groups is concerned, as reflected in the average of 47 targets, there is practically no difference between the Arsenal's 1,000 yard cartridge and the Remington Palma which it defeated by fourteen hundredths of an inch on the average mean radius. That is a three per cent difference, and a difference so small might conceivably be reversed in another trial.

Probably the fairest comparison of the merits of these two cartridges is seen in the 16 additional targets fired by the leading competitors by direction of the Board, in order to break the tie. The average mean radius of the 16 targets fired by Frankford was 3.97; while the aveage for the sixteen targets fired by Remington was 4.408. These targets were all fired exactly at the same time and observing all the other conditions of exact comparability.

Ordnance experts state, no doubt with reason, that if the Palma test had been fired under the ideal conditions which sometimes exist, such as a foggy morning with absolutely no wind, the average mean radius of Frankford's winning lot on the entire series of targets might have been under four inches.

Many riflemen will note advantages in the Frankford Palma load which do not appear in the averages, but may nevertheless aid in winning matches or series of matches. The propellant is a cool-burning progressive powder of the modern type, which keeps the barrel erosion at the minimum and lends itself to obtaining a desirably high velocity with safe chamber pressures. The 9° boat-tail bullet of 172 grains is a projectile not only of great accuracy but of superior wind-bucking quality and greatly increased ranging power. At 1,500 yards its superiority would no doubt be much more evident than at ordinary ranges. Its reduced weight as compared with other wind-buckers permits an increase of initial velocity which in turn cuts down the wind allowances used in the past.

Compared with its rival, Remington-Palma, the Frankford load appears to have the advantages of 173 feet greater velocity at 78 feet from the muzzle. After the firing Charlie Hogue of Frankford stated that their cartridge took seven minutes less elevation and something like ten feet less windage at 1,000 yards, as shown by the readjustments necessary on the machine rests.

The gilding metal jacket decreases both the chances of changed point of impact from metal fouling, and also the labor of keeping match barrels in condition.

If this cartridge has a disadvantage it would appear to lie in the chamber pressures used. Although the Arsenal figures show less pressure than that recorded by the

TABLE 2.
Palma Ammunition: Rank of Competitors and Average Group Measurements Fired at 1,000 yards in groups of ten shots each.

Rank	Competitor	Lot No.	Av. Group Measurements In Inches E.V.	E.H.	Extreme Spread	M.R.	No. of Groups Averaged
1.	Frankford	3	11.54	11.43	14.68	4.46	26†
2.	Remington	2	10.30	12.73	14.14	4.56	26
3.	Frankford	4	11.17	14.22	15.91	4.99	26
4.	Remington	1	14.35	13.43	17.65	5.39	26
5.	Western	3	14.89	14.55	17.95	5.76	26
6.	Western	4	19.75	15.74	22.55	6.74	26
7.	Winchester	101	17.09	19.43	23.41	7.39	26
1.	Remington	2	10.30	12.87	14.62	4.66—	31‡
2.	Frankford	3	11.38	12.17	15.02	4.66-|-	31
3.	Frankford	4	11.33	14.12	15.89	4.93	31
1.	Frankford	3	11.32	10.28	13.45	3.97	16§
2.	Remington	2	11.60–	10.73	13.95	4.41—	16
1.	Frankford	3	11.36	11.53	14.48	4.43	47*
2.	Remington	2	11.07	12.14	14.38	4.57	47

Note.—Basis of award is the mean radius.
† Regular orders, eliminating those in which any competitor had incomplete targets.
‡ Regular orders, eliminating only those in which either Frankford or Remington had incomplete targets.
§ Additional orders, required by the Board to break the tie.
* Total of (‡) and (§)

TABLE 3.
International Match Ammunition: Rank of Competitors and Average Group Measurements Based on 24 Ten Shot Groups. Fired at 300 Meters

Rank	Competitor	AMMUNITION Lot No.	Average Group Measurements In Inches Extreme Vertical	Extreme Horizontal	Figure of Merit
1.	Frankford	2	1.88	2.33	2.11
2.	Remington	4	2.22	2.51	2.36
3.	Western	1	2.19	2.66	2.43
4.	Remington	3	2.31	2.69	2.50
5.	Frankford	1	2.27	2.78	2.53
6.	Western	2	2.54	2.76	2.65
7.	Winchester	302	3.04	3.20	3.12
8.	Winchester	301	3.91	3.78	3.85

Note.—Basis of award is the figure of merit at this range because mean radii are too small to permit satisfactory measurement.

Remington Company, the pressures taken by the Board show about 6,000 pounds more for the new cartridge than for Remington-Palma. Pressure records are notoriously unsatisfactory for comparison on account of the frequent lack of comparable basis in the coppers and in using different pressure guns. The pressure of 52,385 pounds recorded by the Board is not in the least dangerous with modern rifles, but if it is actually 6,000 pounds greater than the Remington cartridge the difference is certainly not an advantage.

It may mean a somewhat heavier recoil. It may mean that even with a nitrocellulose powder there will be undesirable barrel erosion, especially in combination with the boat-tail bullet. It may mean that in the slender barrels of the military rifles, or even the heavier free rifles, there will be less accuracy than the test in thick Mann barrels has led us to expect. These, however, are merely mentioned as possibilities. Frankford experts no doubt know very closely the merits of this load from trial performance in the Springfield rifle. Actual match firing during this summer will reveal any possible objectionable features.

So far as may appear from the test a step in advance has been taken in long range match ammunition, a step so marked that the cartridge is practically a new type.

The *American Rifleman* congratulates Frankford Arsenal on the patient research which resulted in a splendid performance at Aberdeen. The defeated competitors we congratulate as well, for they in fact have given an admirable exhibition of sportsmanship which it is to be hoped will continue and be shared by all of the great cartridge makers.

Western came to the short range with ammunition loaded with 220 grain, soft point hunting bullets. We have thought of hunting loads in terms of six and eight inch groups at 200 yards. Yet Western acquitted herself with credit in competition with the best match ammunition in the world. Can more be said for cartridges designed primarily for smashing power on big game? Their International load was beaten by Remington, but by the narrow margin of .08-inch on the figure of merit. Another test might reverse this difference. Both cartridges were good enough to equip world champions.

Winchester entered ammunition of an advanced type, boat-tail, gilding metal bullets, with high velocity for long range. Although outranked in this unparalleled exhibition of accuracy, their work was a real achievement considering their ten years of non-participation in these tests.

Super-accurate rifle barrels will not make poor ammunition shoot good targets. On the other hand, the finest ammunition in the world will show up poorly when fired from inaccurate or poorly made barrels. It should, therefore, be remembered when admiring the remarkable groups made in the International and Palma Match Tests that all of these targets were made in standard Mann rest barrels 24 inches in length made by Springfield Armory. Usually, in tests of this nature, all of the credit goes to the ammunition. Without detracting in the least from the product of Frankford Arsenal, it should be remembered that this great record would not have been possible without the exceedingly high type of test barrels supplied by Springfield.

Tribute should also be paid to the performance of the personnel of Aberdeen Proving Ground in handling a test such as the International and Palma Match tests. The speed and accuracy with which the targets are obtained and measured are little short of marvelous. In former times, these tests, on the ordinary type of target range, required several days. With the range and range crew available at Aberdeen, it would have been possible to fire both tests in one day, providing the Board had not laid down the requirement that firing should be on two separate days, in order to obtain a comparison under different weather conditions.

One other element was there, invisible but none the less potent. That was the influence of the great body of civilian riflemen, ever impatient of mediocre equipment, ever demanding further improvements, and quick to recognize merit. It is their influence that furnishes stimulus for the generous rivalry between the cartridge companies and the Arsenal, which in turn has brought about the present high grade of ammunition. The Arsenal has now proved that no previous standard is too high to be excelled. Which of the rivals will take the next step toward perfection?

The Third Ammunition Train, Fort Sill

THE Third Ammunition Train has been in existence at the Field Artillery School but two years. In that time it has assumed so important a place in the activities of the post that it is difficult to realize that there was a time when the Field Artillery School was without an ammunition train.

In the last war such trains handled all the transportation for an entire division, and in France the 3rd Ammunition Train was commanded by a Lieutenant Colonel and had the function of supply for infantry, artillery and other organizations. At the present time at the Field Artillery School it is used to haul ammunition for the field artillery batteries. Prior to its arrival the batteries occupied themselves every morning in hauling ammunition from the ordnance warehouses to their organizations. This took from 6 to 8 men away from their organization each day. In other words it necessitated the loss of fifty-four men to the firing batteries of the post, whose personnel are called upon to perform more arduous tasks than any similar organization in the Army.

The Third Ammunition Train has relieved the batteries of that heavy duty and has since September 1924, delivered to the battery parks almost 200,000 rounds of 75-mm. and 3-inch ammunition.

Silver Azide: An Initiator of Detonation[1]

By

C. A. TAYLOR and WM. H. RINKENBACH

A BROAD program of research on silver and its compounds having been undertaken by the U. S. Bureau of Mines for the purpose of finding new and improved uses of this metal and its derivatives, at the suggestion of Dr. Charles E. Munroe, Chairman of the Committee on Explosives Investigations of the National Research Council, it was decided to carry out an investigation of silver compounds having explosive properties. This paper is the first of a series giving the results of this investigation.

Mercury fulminate is the most widely used compound for initiating detonation, but it has two properties that impair its efficiency under some conditions. When it is stored in a moist atmosphere it will absorb some moisture. Detonators in which it is used as a priming charge for TNT or tetryl must have a large excess of the mercury fulminate above the minimum weight required and be protected as well as possible from moisture to insure detonation.

Mercury fulminate will decompose slowly at the temperature that exists in some tropical countries.

The detonating compounds of silver have been known for some time. Silver azide is the first to be studied.

Curtius[2] first described silver azide in 1890; Wöhler[3] determined some of its properties in 1907, and in 1918 Hitch[4] added to the data. Other investigators will be mentioned later in connection with particular properties which they determined.

Preparation

Wöhler and Matter describe the preparation of silver azide by the action of silver nitrate on ammonium azide according to the equation,

$$AgNO_3+NH_4N_3=AgN_3+NH_4NO_3$$

Browne[5] showed that it could be formed quantitatively by electrolytic action on silver electrodes in hydronitric acid.

Hodgkinson[6] patented a process whereby sodium azide is produced in a solution and reacts immediately with silver nitrate which is present in the solution. He also patented a process for the preparation of silver azide in a diazotizing solution.

Hitch prepared silver azide in a very pure form by treating a 4 per cent solution of silver nitrate with a slight excess of a 4 per cent solution of hydronitric acid. The hydronitric acid solution was prepared by distilling the acid into water from the reaction of sodium azide with 6N. sulphuric acid. The reaction is as follows:

$$2NaN_3+H_2SO_4 \rightarrow Na_2SO_4+2HN_3$$
$$HN_3+AgNO_3 \rightarrow AgN_3+HNO_3$$

The silver azide used in the following tests was made from concentrated solutions of silver nitrate and sodium azide to insure the formation of small crystals.

Thirty-four grams of $AgNO_3$ were dissolved in 50 c.c. of water, and slowly added to a solution of 13.5 grams of NaN_3 in 70 c.c. of water with constant stirring. The precipitate of Agn_3 formed rapidly, giving small crystals. These were filtered off, washed first with water, then with alcohol and ether to facilitate drying; dried in a current of dry air, and kept in a sulphuric acid desiccator. One sample was made from dilute solutions giving larger crystals.

Physical Properties

The silver azide prepared from the concentrated solutions consisted of colloidal aggregates so small that it was impossible to measure the individual particles under a magnification of 800 diameters. Both products were clear white and remained so when kept in a dark place. Both became cream color when exposed to sunlight, and melted at 251° C. The colloidal product detonated at 273° C. It decomposed rapidly above its melting point to silver and nitrogen. The weight remained constant when samples were heated at 75° C. for 24 hours.

It was very slightly soluble in water, alcohol, ether, and acetone as shown by the following results:

Weight of AgN_3 gram	Soluble in
0.006	100 grams of water
0.017	100 grams of ether
0.006	100 grams of 95% alcohol
0.015	100 grams of acetone.

Silver azide is not hygroscopic. Samples of 2 grams each were left in a saturated atmosphere at room temperature for two weeks and increased only 0.04 per cent in weight.

Detonating Properties

The material prepared from concentrated solutions as given above required the drop of a 500-gram weight through 777 millimeters to cause detonation, while the coarser crystals prepared with dilute solutions required a drop of 285 millimeters; mercury fulminate required 127 millimeters.

It required 0.05 gram of both the colloidal and coarser silver azide to cause the detonation of 0.4 gram of TNT confined in a No. 6 detonator capsule whether the charge was confined by a reinforcing cap or not, as compared with 0.24 gram of mercury fulminate when the charge

1 Published by permission of the Director, U. S. Bureau of Mines.
2 Curtius; Berichte *23*. (1890), p. 3023; *24* (1891), p. 3341.
3 Wöhler and Matter, Zeit für ges Schiess U. Sprengg. *2* (1907) 181, 203, 244, 265.
4 Hitch; J. A. C. S. *40* (1918) p. 1195.
5 Browne; J. A. C. S. *41* (1919) p. 1769.
6 British Patents No. 128014, June 17, 1918; 129152, Aug. 8, 1918.

was confined by a reinforcing cap and 0.37 gram when not confined.

Different weights of dry silver azide were loaded into No. 6 detonator capsules and compressed under a pressure of 1,000 pounds per square inch. These detonators were fired in the Bureau of Mines[7] sand test bomb No. 2 and gave the following results, compared with equal weights of mercury fulminate loaded in the same way:

Weight of charge. grams	Weight of sand crushed, grams. By silver azide	By mercury fulminate
0.05	1.4	.00
.10	3.3	.00
.20	6.8	4.2
.30	10.4	8.9
.50	18.9	16.0
.75	30.0	26.1
1.00	41.1	37.2

A detonator containing 0.2 gram of silver azide detonated an insensitive gelatin dynamite that failed to detonate with a detonator containing 1 gram of mercury fulminate.

Stettbacher[8] gives the heat of detonation of silver azide as 452 calories per gram, and its explosive power as 192,000 kilogrammeters compared with 175,000 k. g. m. for mercury fulminate.

Detonators made by pressing 0.10 gram of the silver azide on top of 0.40 gram of TNT detonated completely after 30 days storage in a saturated atmosphere at room temperature, and crushed the same weight of sand as when dry. Detonators containing 0.4 gram of mercury fulminate on 0.4 gram of TNT with a reinforcing cap failed to detonate until redried.

Summary

Hitch gives the melting point of silver azide as 251.5° C. compared with 251° C. determined by the writers. Wöhler gave the drop of the 500 gram weight in the impact test as 130-mm. for mercury fulminate as compared with the value of 127-mm. found by the writer, and his results for silver azide of 310 mm. agreed with the results of 285 mm. for the coarser product compared to 777 mm. for the colloidal particles. Wöhler also found that 0.05 gram could detonate TNT as readily as 0.24 gram of mercury fulminate. So it appears that the product consisting of small particles made from the concentrated solution is safer to handle while it retains its other properties the same. Detonators can be made with a main charge of TNT, tetryl or other nitro substitution product and a priming charge of silver azide that can compete with the standard mercury fulminate-potassium chlorate detonators on the market and they may prove to be superior to the fulminate chlorate detonator under some conditions of humidity and temperature.

7 Bureau of Mines Reports of Investigations, Serial 2558 (1923) Methods of Testing Detonators. Taylor and Munroe.

8 Stettbacher, Zeit für ges Schiess u. Spreng *10* (1915) pp. 193 214.

Current Ordnance Development at Rock Island Arsenal

THE first type of Power Cart, Model 1924E, with a radius turn accomplished through brakes on each side of the differential, has been completed and given about a 30-mile preliminary test, and also a short test through severe conditions of grades and mud. Through these tests, it has shown up very well, and has demonstrated a very good maneuvering ability through the most severe conditions. However, certain minor changes are found necessary, which are now being made, before any further testing will be attempted.

Approval has been received from the Ordnance Office and from the Technical Staff on the final drive unit of the Medium Tank. The details of this unit having been submitted to the Chief of Ordnance and approved with certain minor changes, the unit will shortly be released for manufacture.

The status of the design work on the Medium Tank is as follows:

The upper and lower turrets for Phase II have been detailed, and the details sent to the Ordnance Office for approval. The foot brakes for Phase I, to be used on the Model 1921 tank now at Aberdeen, have been released for manufacture. The suspension and front idler have been released for manufacture. The final drive units for Phase II have been released for manufacture. The wooden model for a built-up track according to the design furnished by the Ordnance Office has been made and sent to the Ordnance Office.

The following units are now being detailed, and will be submitted to the Ordnance Office for approval during the coming month: compound epicyclic, simple epicyclic, compound master clutch, plate master clutch, and transmission, all of the above being for the Phase II tank.

The fan drive under Phase I work, to be used on the tank at Aberdeen, is now being detailed. The motor suspension, also for the above work under Phase I, is being detailed.

No definite conclusions have been reached in connection with the redesign of the compound clutch or the compound epicyclic with antifriction bearings for the Medium Tank. A wooden model is being made of the forged track link with stamped shoe for this type of vehicle, in accordance with designs furnished by the Ordnance Office.

Layouts of lengthened outriggers of the Mark IX Motor Gun Carriage are being detailed and will shortly be released for manufacture.

Studies have been submitted to the Ordnance Office in connection with the weight distribution of the 4.7-inch Gun Motor Carriage, Mark X. These studies cover a certain amount of redesign, in order to secure a better distribution of the weight of this vehicle.

A test was made on the new drawbar for the 10-ton trailer. However, it did not show up to advantage, probably on account of the fact that the test was made with the old type of pintle. It is understood that one of the new pintles will be sent to Rock Island from Aberdeen, and upon receipt of this pintle, additional tests will be made.

Machine shop activities on ordnance have centered principally on reconditioning and parts for tank, trailer and artillery matériel from store. Work on the second Pack Howitzer Carriage, Model 1923, and the experimental Cargo Cart is delayed because of non-receipt of steel and malleable castings.

Editorials

Army Ordnance Trophy For National Matches

THE Army Ordnance Association announces that it has offered to award annually, through the National Rifle Association, an Ordnance trophy to the winner of the President's Match at the National Matches, the trophy to consist of a Springfield Rifle of especially fine workmanship. A new rifle embodying the latest improvements will be awarded each year, the trophy in each case to become the individual property of the winner. For the 1925 President's Match it has been decided to award the rifle known as the "Springfield Sporter."

Frankford Ammunition Wins

THIS issue of ARMY ORDNANCE contains an account of the signal honor won by Frankford Arsenal in having its special match ammunition selected for the International and Palma Matches as the result of a competitive test.

Both of these matches are historically and internationally famous. The International Match in this country would ordinarily be classed as a short range match. However, this does not mean it is an easy match, as the competitive conditions under which it is fired make it very difficult. The winning team and the highest individual in the International Match are truly champions of the world. The Palma Match is significant of America and the American rifle. It is for long range what the International is for short range. In fact the Palma trophy is emblematic of the long range team championship of the world.

The importance of these Matches requires the selection of ammunition of the very highest quality, and ammunition makers consider the winning of these tests much the same as the team does the actual match.

Since the renewal of the National Matches after the War, Frankford Arsenal has developed the manufacture of machine-loaded National Match ammunition to the point where it had become nearly the equal of the best hand-loaded special match ammunition previously selected. Commercial cartridge companies, while acknowledging the superiority of the machine-loaded Government ammunition in quantity production, could point with pride to the fact that, insofar as special types are concerned, the demands of the world's greatest riflemen could only be met by ammunition of commercial manufacture. Frankford's success, therefore, has established a new standard for special ammunition, as well as for quantity manufacture.

The achievement of making the most accurate rifle ammunition yet produced is eclipsed by the manner in which this ammunition was developed. The World War demanded ammunition of flatter trajectory and longer range than the old types. The longer range could not be obtained, except by using a stream-line or boat-tail bullet. Previous experience had shown that the improved ballistic qualities with regard to trajectory and range could only be obtained at the sacrifice of accuracy. Accuracy to the American rifleman, founded as it is on tradition, is paramount. Against the opposing views of ballistic experts the world over, Frankford Arsenal, using the development of National Match ammunition as the basis, continued to improve its methods of manufacture of boat-tail bullets until their inaccuracy had been eliminated and was replaced, not by accurate standards, but by superaccurate standards.

There has resulted thereby the remarkable accomplishment of one general type of ammunition becoming a standard for the proposed new service ammunition of the United States Army, the National Match ammunition, the International Match ammunition, and the Palma Match ammunition.

Our commercial manufacturers of small arms ammunition are to be highly commended for their remarkable achievements and fine spirit of cooperation in the production of National Match types. To Frankford Arsenal ARMY ORDNANCE extends its congratulations for its remarkable record in developing small arms ammunition of such superior characteristics.

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ORDNANCE
WASHINGTON

May 1, 1925.

Subject: Commendation for Winning International and Palma Match Tests.

To: The Commanding Officer, Frankford Arsenal, Philadelphia, Pa.

1. The Chief of Ordnance notes with pride the remarkable record made by Frankford Arsenal's Special Match Ammunition in winning the International and Palma Match tests with accuracy figures exceeding those of tests of previous years.

2. The Commanding Officer, Officers and Civilian Employees of the Arsenal are to be commended for their meritorious services in developing and perfecting ammunition of such outstanding excellence.

Major General, Chief of Ordnance.

Ordnance Reserve Officer Training, 1925

THE Ordnance Department has made extensive plans for the training of Reserve Officers during the summer training period, 1925. There will be a class of students of the Branch Assignment group who will assemble during June and another, divided into two sections, one of which will train at Aberdeen Proving Ground, the other at Rock Island Arsenal, during August. An announcement concerning the June training courses is published in the Reserve Corps Notes Department of this issue, and

details concerning the August courses will be given in the July-August number of ARMY ORDNANCE. Plans for the training of Territorial Assignment officers are being made by Corps Area Commanders.

The activity and interest being shown by Ordnance Reserve Officers not only in the summer courses but in instruction classes held in various centers throughout the winter are most encouraging. Interest in this important branch of national defense seems at a higher pitch than ever before. Those to whom a reserve commission formerly meant a mere paper assignment are now actively engaged in problems and training courses which, while in many cases are difficult of fulfillment due to other necessary activities, are, nevertheless, being wholeheartedly undertaken. Throughout the entire country the Ordnance Reserve is cooperating in a most enthusiastic manner.

We would urge all those who can possibly spare the time to apply for enrolment in one of the summer courses.

It is understood that active training will be one of the requirements for promotion under the new regulations now in effect but aside from this requirement the training has features in which every Ordnance Reserve Officer should be interested. It gives him actual experience both in the test, manufacture and use of ordnance matériel as well as an intimate knowledge of the operation of the Department. Charged with tremendous responsibilities in war, the Ordnance Department is a complex organization operating over the entire continental limits of the United States and the insular and foreign possessions. Reserve Officers are apt to believe that their World War experience has given them a thorough knowledge of their duties, but post-war changes both in organization and development are matters which warrant their constant study and application. Upon the success of the reserve officers' active training courses in 1925 depends much of the effectiveness of the Ordnance Reserve Corps, and in the long run, of the real value of the Reserve Corps as a whole.

Reserve Officers will do well to think the matter over seriously and apply immediately for training during the coming summer.

Our Contributors

MAJ. GEN. CHARLES G. SUMMERALL, Commanding General of the Second Corps Area, stationed at Governors Island, N. Y., was the principal speaker at the annual meeting of the New York Post of the Army Ordnance Association, April 6, 1925. General Summerall commanded the First Division, A. E. F., and was one of the principal American military leaders in the World War. His work since the Armistice has been equally effective and he is an enthusiastic proponent of adequate industrial preparedness.

Mr. Charles McKnight, Jr., author of "Mill Inspection of Steel," is one of the staff experts of the development and research department of the International Nickel Company. He served overseas as an officer of Field Artillery, and upon his return became works manager of the Carbon Steel Company in Pittsburgh. He now holds a reserve commission of Major of Field Artillery, and in addition has done some important research in the manufacture of steel and steel products.

Dr. Tenney L. Davis is Professor of Organic Chemistry at the Massachusetts Institute of Technology where he has carried on some of the major researches for the Ordnance Department in the manufacture and development of new explosives. His article, "Chemistry in War: An 18th Century Viewpoint," is an interesting bit of historical data concerning the importance of chemistry in battle two centuries ago.

Mr. Emil Gathmann, of The Gathmann Engineering Company of Baltimore, Md., discusses an important development in steel manufacture—the big-end-up steel mold. His article on "Improved Quality Steel Production" is an excellent description of this important process.

Dr. Fritz Heigl, whose article on "Italian Tanks" appears in this issue, is an Assistant Professor at the Technical High School in Vienna. He has written a great deal on military subjects and his description of Italian tanks is, we believe, one of the best treatises that has yet appeared on this subject. In this connection readers are referred to an article, "German Tanks," by R. Kruger, published in ARMY ORDNANCE, July-August 1923, Vol. 3, No. 19. We hope to publish a paper by Dr. Heigl on French Tanks in an early issue.

Capt. W. W. de Sveshnikoff, in his article "Carburization as a Factor in the Erosion of Machine Gun Barrels," contributes a very important paper to the general literature on this subject. Captain de Sveshnikoff has done considerable work in this field, and, among others, is the author of "Some Factors Affecting the Life of Machine Gun Barrels" (Technologic Paper of the Bureau of Standards No. 191). His article is followed by a discussion of the subject which has been contributed to by many of the foremost authorities on the subject in this country.

Major Glenn P. Wilhelm, who presents Part II of his important discussion of "Small Arms: Their Manufacturing Requirements," is well known to the readers of ARMY ORDNANCE. He is Chief of the Infantry and Aircraft Armament Division, Manufacturing Service, Office of the Chief of Ordnance, and is an acknowledged authority on all small arms questions.

Mr. R. V. Reynolds, author of "Frankford Arsenal Ammunition Wins National Match Tests," is a member of the Board for Determining Types of Arms and Ammunition for the National and International Matches for 1925. He is a director of the National Rifle Association. His account of the Frankford Arsenal victory describes the tests fully. It is reprinted in ARMY ORDNANCE by courtesy of the Editor, *The National Rifleman*.

The paper on "Silver Azide" is the joint work of Messrs. C. A. Taylor and W. H. Rinkenbach of the Bureau of Mines Experiment Station, Pittsburgh, Pa. Mr. Taylor has been in charge of the Explosives Testing Laboratory at Pittsburgh since 1920. Mr. Rinkenbach is an assistant chemist at the Experiment Station. Their recent contribution to these pages (H. M. T. D.—A New Detonating Explosive, ARMY ORDNANCE, Vol. V, No. 25, July-August 1924) was very enthusiastically received both in this country and abroad.

Reserve Corps Notes

Items of Interest to Members of the Ordnance Department Reserve

Edited by Major John A. Brooks, Jr., Military Personnel Section, Office of the Chief of Ordnance

Spring Training

ARRANGEMENTS are being made for training about one hundred officers of the Branch Assignment Group during May and June of this year. Training courses have been arranged at the Presidio of San Francisco, California, from May 10th to 24th, and at Watertown Arsenal, Watervliet Arsenal, Springfield Armory, and Frankford Arsenal from May 31st to June 14th. A few officers will be trained at San Antonio Arsenal and in various divisions of the Ordnance Office in Washington. Several officers are also being called to duty in the district offices.

Applications for training are being received daily so that the complete list of officers to be trained this spring is not yet available.

Summer Training

FUNDS have been received and plans are being made for summer training of members of the Branch Assignment Group. A training camp will be conducted at Aberdeen Proving Ground from August 2nd to 16th, and one at Rock Island Arsenal from August 16th to 30th. Commanding officers of Ordnance establishments, chiefs of district offices, and chiefs of divisions of the Washington office will shortly be asked to recommend officers for training at these camps. It is suggested that officers who desire training this summer notify their places of assignment without delay.

The present courses at Aberdeen and Rock Island are basic training courses applicable to all officers of the Ordnance Department Reserve, irrespective of their assignments. It is the purpose of these courses to give an officer a general knowledge of the various kinds of matériel furnished by the Ordnance Department. It is contemplated that each member of the Branch Assignment Group will be given an opportunity at some time to take one of these basic courses unless the officer lives at so great a distance that funds will not permit of the necessary travel. In such cases arrangements will be made to train officers in other ways.

The camp at Rock Island will be as similar to the one at Aberdeen as existing facilities will permit. At Aberdeen the matériel will be studied largely from the standpoint of construction and test, whereas at Rock Island Arsenal there are fewer facilities for testing, and the instruction will be largely from the standpoint of construction and manufacture.

The course at Aberdeen will include instruction in the following subjects: seacoast artillery, antiaircraft artillery, fire control instruments, trench warfare matériel, small arms, artillery ammunition, small arms ammunition, establishment of charge, pressure, velocity curves, field service activities, automotive equipment, including tanks, tractors, and motor carriage artillery, bombs and bombing, and other related subjects.

Each morning at reveille officers will be given calisthenics for ten or fifteen minutes. Breakfast will be followed by about forty-five minutes of Infantry Drill. Each officer will be given an opportunity to command a platoon at some time during this military instruction.

The officers' camp at Aberdeen immediately follows the R. O. T. C. camp and the officers will therefore occupy the quarters and use the mess and recreation room established for the R. O. T. C. During the 1924 camp the mess charges, including janitor service and laundering of bed linen, amounted to $20.00 for the period of the camp.

It is believed that the schedule of calls will be approximately as follows:

(Call)	(Week days)	(Sunday)
Reveille, 1st call	5:45 A. M.	——
Reveille	5:58 A. M.	——
Assembly	6:00 A. M.	——
Mess call	6:25 A. M.	7:25 A. M.
Sick call	6:55 A. M.	7:55 A. M.
Drill, 1st call	6:55 A. M.	——
Assembly	7:00 A. M.	——
Ordnance instruction		
1st call	7:55 A. M.	——
Assembly	8:00 A. M.	——
Recall	12:00 M.	——
(Lecture, if any, to be given from 8:00 to 9:00)		
Mess call	12:10 P. M.	12:10 P. M.
Ordnance instruction		
1st call	1:00 P. M.	——
Assembly	1:05 P. M.	——
Recall	3:00 P. M.	——
Mess call	6:00 P. M.	6:00 P. M.

This schedule has been prepared in accordance with the recommendations of the majority of officers who attended the 1924 camp. It is proposed to complete the military instruction during the early morning and to complete all instruction by 3 o'clock in the afternoon in order that sufficient time may be available for using the library, for investigating special activities of the proving ground, and for athletics.

Tennis courts are available and a nine-hole golf course adjoins the barracks. The majority of officers go swimming in Chesapeake Bay at some time during the afternoon. The swimming dock is about a quarter of a mile from the quarters. It is expected that each officer will be given an opportunity to take a short flight in one of the planes at some time during the camp.

Officers who are recommended for training will receive from the Ordnance Office an official letter announcing the date and place of training, and asking the officer to complete an indorsement accepting training at the time and place indicated. Upon the receipt of these replies the

Ordnance Office will request The Adjutant General to issue the necessary orders. Requests which cannot be complied with on account of lack of funds will be acknowledged, and every effort will be made to advise officers as to their exact status in sufficient time for them to make their plans for the summer. The Commanding Officer at Aberdeen or Rock Island will send to each officer, as soon as his orders have been issued, special instructions regarding the conduct of the camp, the uniforms required, and other information of interest to him.

Prizes for Essays on Ordnance Training

THE following item appeared in the *Yale News* for March 23rd:

"An anonymous donor has offered prizes of $50, $25, $15, and $10, respectively, to be awarded in June for the four best assays submitted on the topic: The Training and Development of Ordnance Officers for the United States Army Especially from the Viewpoint of the Ordnance Reserve Corps.

"The competition is open to all R. O. T. C. students in the University. All essays, together with accompanying maps, drawings, other diagrams, and photographs are due at the office of the University Secretary, Woodbridge Hall, not later than noon of May 16."

Regulations for the Officers' Reserve Corps

ARMY Regulations 140-5 has now been distributed. These regulations include information pertaining to the appointment, assignment, training, promotion, and separation of officers of the Reserve Corps. It is believed that the section on promotion will be of special interest and this section will be published in the next issue of ARMY ORDNANCE.

The standard specifications for promotion will be published by the War Department prior to July 1, 1925. Funds will not permit a sufficient number to be printed so that they may be distributed to all reserve officers. Therefore, an effort will be made to publish these specifications in the next issue of ARMY ORDNANCE.

R. O. T. C. NOTES

Summer Camp

THE R. O. T. C. camp at Aberdeen Proving Ground will open on June 19th and close July 30th. It is expected that about 200 students will be present at this camp, representing Massachusetts Institute of Technology, Cornell University, Yale University, Georgia School of Technology, University of Cincinnati, University of Michigan, and the University of Wisconsin.

Training for Graduates

A course of training at Watertown Arsenal from June 14th to 28th has been arranged for a few of this year's graduates of the R. O. T. C. Those students who have done the best work in the R. O. T. C. will be ordered to active duty for fifteen days as reserve officers. They will receive the regular pay of second lieutenants and mileage at the rate of four cents per mile between their homes and the arsenal. This opportunity to visit the arsenal and to become familiar with the experimental work in the laboratory should be of much professional interest to the young engineer, and it is hoped that it will be possible to arrange such a course each year.

Recently Reappointed Ordnance Reserve Officers

THE following reserve officers have accepted reappointments in the Ordnance Department Reserve:

Col. Mervyn A. Rice, Ord. Res.,
99 Central Ave., Montclair, N. J.
Col. Charles H. Tenney, Ord. Res.,
care of Springfield Gas Light Co.,
Springfield, Mass.
Lieut. Col. Joseph J. Daly, Ord. Res.,
100 E. 42nd St., New York, N. Y.
Lieut. Col. Walter A. Dibblee, Ord. Res.,
3412 Hallwood Place, Cincinnati, Ohio.
Lieut. Col. Thomas F. Flynn, Ord. Res.,
2320 N. 22nd St., Philadelphia, Pa.
Lieut. Col. James F. Monaghan, Ord. Res.,
105 Waltham St., West Newton, Mass.
Major John Chrosniak, Ord. Res.,
122 Ridgeside Road, Chattanooga, Tenn.
Major Claude B. Clarke, Ord. Res.,
Box 109, Route 3, San Antonio, Tex.
Major James Forrestal, Jr., Ord. Res.,
282 Madison Ave., Flushing, N. Y.
Major Fred C. Hosea, Ord. Res.,
34 Gledhill Ave., Everett, Mass.
Major Gilbert N. Huntting, Ord. Res.,
124 Halstead St., East Orange, N. J.
Major Harold B. Johnson, Ord. Res.,
68 Montague St., Brooklyn, N. Y.
Major Walter J. Munro, Ord. Res.,
12945 Cedar Road, Cleveland, Ohio.
Major William F. Odom, Ord. Res.,
10 Slater St., Saylesville, R. I.
Major Frank J. O'Hara, Ord. Res.,
Water Users Bldg., Phoenix, Ariz.
Major David R. Reynolds, Ord. Res.,
806 Third Place, Plainfield, N. J.
Major Earle T. Robinson, Ord. Res.,
115 C St., San Diego, Calif.
Major Louis B. Runk, Ord. Res.,
17 West Upsal St., Mt. Airy, Phila., Pa.
Major Winfred A. Sabin, Ord. Res.,
2663 10th St. W., Seattle, Wash.
Major James S. Smyser, Ord. Res.,
24 Milk St., Boston, Mass.
Major James Spiers, Ord. Res.,
Martell, Calif.
Major Frank A. Sullivan, Ord. Res.,
P. O. Box 507, Sawtelle, Calif.
Capt. Charles W. Aldridge, Ord. Res.,
San Diego High School, San Diego, Calif.
Capt. Elmer S. Barkhurst, Ord. Res.,
Fort Bragg, N. C.
Capt. Humphrey Beckett, Ord. Res.,
Lanham, Md.
Capt. Robert W. Blair, Ord. Res.,
5736 Blackstone Ave., Chicago, Ill.
Capt. George R. Bliss, Ord. Res.,
Carpinteria, Calif.

Capt. James H. Boerckel, Ord. Res.,
2136 Bridge St., Frankford, Phila., Pa.
Capt. John W. Brockhage, Ord. Res.,
Box 355, Berkeley, Calif.
Capt. Richard J. Clark, Ord. Res.,
3145 Kellog St., Point Loma, Calif.
Capt. Henry A. Clawson, Ord. Res.,
General Ord. Depot, Charleston, S. C.
Capt. Alonzo E. Cook, Ord. Res.,
Hdqrs. 2nd Div., Camp Travis, Tex.
Capt. John E. Dixon, Ord. Res.,
515 West Seneca St., Ithaca, N. Y.
Capt. Fred E. Fish, Ord. Res.,
116 Stockton St., Elkton, Md.
Capt. John M. Floyd, Ord. Res.,
Fort Benning, Ga.
Capt. Edgar F. Gates, Ord. Res.,
Girard, Ill.
Capt. Thomas Glaney, Ord. Res.,
West Palm Beach, Fla.
Capt. Ralph A. Gregory, Ord. Res.,
8932 Tudor Ave., St. Johns Station, Mo.
Capt. John H. Hall, Ord. Res.,
936 Victoria Ave., San Leandro, Calif.
Capt. Frederick D. Hansen, Ord. Res.,
University Club, Milwaukee, Wis.
Capt. Henry J. Hartley, Ord. Res.,
682 Ft. George Ave., New York, N. Y.
Capt. William G. Hynds, Ord. Res.,
154 Nassau St., Room 1514, New York, N. Y.
Capt. John M. Kelly, Ord. Res.,
2840 Shady Ave., Pittsburgh, Pa.
Capt. Howard Logan, Ord. Res.,
5336 Cornell Ave., Chicago, Ill.
Capt. Neil H. McKay, Ord. Res.,
7240 Hillside Ave., Los Angeles, Calif.
Capt. Lesley McVicar, Ord. Res.,
Edgewood Arsenal, Md.
Capt. William F. Mahony, Ord. Res.,
1817 Newton St., Washington, D. C.
Capt. Michael D. Maloney, Ord. Res.,
Hawaii Arsenal, Honolulu, H. T.
Capt. John R. Manegold, Ord. Res.,
3025 Highland Blvd., Milwaukee, Wis.
Capt. Camille A. Meyer, Ord. Res.,
118 West 16th St., Davenport, Iowa.
Capt. Joseph H. Nichols, Ord. Res.,
Box 282, Penn. Ave. Station, Washington, D. C.
Capt. Erie Nilan, Ord. Res.,
Box 116, Glenn, Calif.
Capt. Thomas S. Orr, Ord. Res.,
206 Guardian Trust Bldg., Denver, Colo.
Capt. Amos T. Pagter, Ord. Res.,
4606 16th St. N. W., Washington, D. C.
Capt. Homer A. Plunkard, Ord. Res.,
5129 Sheridan Road, Chicago, Ill.
Capt. Richard J. Regan, Ord. Res.,
81 Washington St., Marlborough, Mass.
Capt. Henry G. Roberts, Ord. Res.,
70 Broad St, Newark, N. J.
Capt. Osee L. Rogers, Ord. Res.,
Hawaiian Ord. Depot, Honolulu, H. T.
Capt. Kilian Schmitt, Ord. Res.,
Camp Ord. Office, Camp Lewis, Wash.
Capt. William E. Sidney, Ord. Res.,
Pocomoke City, Md.
Capt. Walter E. Thorp, Ord. Res.,
3628 East 163rd St., Cleveland, Ohio.
Capt. Charles J. Van Amburgh, Ord. Res.,
123 Landseer St., West Roxbury, Mass.
Capt. Earle L. Westlake, Ord. Res.,
2869 Union St, San Francisco, Calif.
1st Lieut. Roger Q. Andrues, Ord. Res.,
Pig Point, Ord. Res. Depot, Pig Point,
Portsmouth, Va.
1st Lieut. Walter H. Beckett, Ord. Res.,
Lanham, Md.
1st Lieut. John H. Bledsoe, Ord. Res.,
5149a North Market St., St. Louis, Mo.
1st Lieut. William H. Bruhn, Ord. Res.,
104 N. Elmwood Ave., Davenport, Iowa.
1st Lieut. Charles O. Chatterton, Ord. Res.,
300 Oregonian Bldg., Portland, Ore.
1st Lieut. Harold S. DeMeritt, Ord. Res.,
2929 24th St. N. E., Washington, D. C.
1st Lieut. Charles Driver, Ord. Res.,
4324 Francis St., Kansas City, Kans.
1st Lieut. George E. Frahm, Ord. Res.,
135 Scott St, San Francisco, Calif.
1st Lieut. Carroll M. Gamble, Ord. Res.,
230 Elm St., Ottawa, Kans.
1st Lieut. Christopher G. Hacker, Ord. Res.,
Hdqrs. 7th Corps Area, Omaha, Nebr.
1st Lieut. Ed M. Harrison, Ord. Res.,
1009 Browder St., Dallas, Tex.
1st Lieut. George F. Holmquist, Ord. Res.,
Scott Ave., Watertown, Conn.
1st Lieut. John M. Inman, Ord. Res.,
Frankford Arsenal, Phila., Pa.
1st Lieut. Livingston R. Jeffords, Ord. Res.,
2840 Thomas Ave., Fresno, Calif.
1st Lieut. Herbert S. Lester, Ord. Res.,
100 East 42nd St., New York, N. Y.
1st Lieut. Carl E. Lucke, Ord. Res.,
70 Haven Ave., New York, N. Y.
1st Lieut. Joseph E. McLaughlin, Ord. Res.,
1624 14th Ave., Altoona, Pa.
1st Lieut. Clarence B. Nichols, Ord. Res.,
Youngstown, N. Y.
1st Lieut. Joseph L. Parker, Ord. Res.,
Aberdeen, Md.
1st Lieut. Norman N. Pearson, Ord. Res.,
Philippine Ord. Depot, Manila, P. I.
1st Lieut. John E. Sauers, Ord. Res.,
Hdqrs. 3rd Corps Area, Baltimore, Md.
1st Lieut. Clifford W. Scholle, Ord. Res.,
5304 N. 15th St, Philadelphia, Pa.
1st Lieut. Walter H. Silpath, Ord. Res.,
2401 Chestnut St., Philadelphia, Pa.
1st Lieut. Edward C. Starr, Ord. Res.,
Fort H. G. Wright, Fishers Island, N. Y.
1st Lieut. Henry C. Tilden, Ord. Res.,
1507 Monte Vista St., Pasadena, Calif.
1st Lieut. Glenn L. Tower, Ord. Res.,
Box 745, Royal Oak, Mich.
1st Lieut. Ralph M. Warner, Ord. Res.,
R. F. D. No. 1, Bridgeport Ave., Milford, Conn.
1st Lieut. Alvin R. Whitlock, Ord. Res.,
425 Hambury St., Germantown, Phila. Pa.
1st Lieut. Edward C. Williams, Ord. Res.,
5207 Pine St., Inglewood, Calif.

1st Lieut. Edward Willis, Ord. Res.,
Hq. 5th Corps Area, Ft. Hayes, Columbus, O.
2nd Lieut. Ivan L. Ayers, Ord. Res.,
29 South LaSalle St., Chicago, Ill.
2nd Lieut. Herbert A. Arronet, Ord. Res.,
Ordnance Office, Camp Meade, Md.
2nd Lieut. Harry F. Baker, Ord. Res.,
172 Main St., Springfield, Mass.
2nd Lieut. Charles V. Bishop, Ord. Res.,
2 Baker Apts., Indianapolis, Ind.
2nd Lieut. Reuben D. Clark, Ord. Res.,
18 Linwood Ave., Warsaw, N. Y.
2nd Lieut. James Cooper, Ord. Res.,
Fort Rodman, Mass.
2nd Lieut. William S. Gould, Jr., Ord. Res.,
Box 154, Greenville Jct., Me.
2nd Lieut. Henry M. Hermann, Ord. Res.,
care of B. H. Stief Jewelry Co., Nashville, Tenn.
2nd Lieut. Claude Jacox, Ord. Res.,
144 Stevens St., Wellsville, N. Y.
2nd Lieut. Archibald A. Love, Ord. Res.,
Ancker Hospital, St. Paul, Minn.
2nd Lieut. Melvin Mayo, Ord. Res.,
4606 Central Ave., Los Angeles, Calif.
2nd Lieut. Karl N. Pollard, Ord. Res.,
1684 Overton Park Ave., Memphis, Tenn.
2nd Lieut. Benjamin H. Riggs, Ord. Res.,
47 Allen Ave., Portland, Me.
2nd Lieut. Paul W. Rokohl, Ord. Res.,
9114 121st St., Richmond Hill, N. Y.
2nd Lieut. John M. Tibbetts, Ord. Res.,
Air Depot, Middletown, Pa.

Recently Appointed Ordnance Reserve Officers

THE following have accepted reserve commissions since last issue of ARMY ORDNANCE:

Lieut. Col. Page S. Bunker, Ord. Res.,
500 Dexter Ave., Montgomery, Ala.
Lieut. Col. George E. Carpenter, Ord. Res.,
11 Randall St., Waterbury, Vt.
Lieut. Col. Earle B. Norris, Ord. Res.,
719 6th Ave., So. Bozeman, Mont.
Major Edward M. Ayer, Ord. Res.,
636 Garfield Ave., Rockford, Ill.
Major A. Linton Bausman, Ord. Res.,
54 Atwater Terrace, Springfield, Mass.
Major Elmer J. Bryant, Ord. Res.,
19 James St., Greenfield, Mass.
Major James F. Carle, Ord. Res.,
4024 Summit Ave., Birmingham, Ala.
Major Lyman M. Dawes, Ord. Res.,
10 Chauncy St., Suite 42, Cambridge, Mass.
Major Carlos de Zafra, Ord. Res.,
317 West 83rd St., New York, N. Y.
Major Jules Dierckx, Ord. Res.,
70 Washington St., Brooklyn, N. Y.
Major Howard W. Dix, Ord. Res.,
530 Riverside Drive, New York, N. Y.
Major John Edwards, Ord. Res.,
1332 N. 4th St., Columbus, Ohio.
Major Robert L. Fulton, Ord. Res.,
1627 East 13th St., Des Moines, Iowa.
Major Perry W. Goodman, Ord. Res.,
San Antonio Arsenal, Tex.
Major Charles O. Gunther, Ord. Res.,
Grand View-on-Hudson, Nyack, N. Y.
Major Adolph W. Lissauer, Ord. Res.,
451 Baxter Ave., Louisville, Ky.
Major Charles F. Morley, Ord. Res.,
276 Seneca Parkway, Rochester, N. Y.
Major Emil F. Norelius, Ord. Res.,
10 Courtland Apts., Davenport, Iowa.
Major Ambrose E. Ridenour, Ord. Res.,
325 S. 13th St., Corvallis, Ore.
Major William L. Sayers, Ord. Res.,
50 Montgomery Place, Brooklyn, N. Y.
Major Robert A. Smith, Ord. Res.,
Mahwah, N. J.
Capt. Robert E. Baker, Ord. Res.,
434 Shady Ave., Pittsburgh, Pa.
Capt. Arthur D. Champlin, Ord. Res.,
4 Westminster St., Providence, R. I.
Capt. Charles W. Francis, Ord. Res.,
859 Thornhill Drive, Cleveland, Ohio.
Capt. Wilbur M. Jefferys, Ord. Res.,
3029 13th St. N. W., Washington, D. C.
Capt. Daniel A. Linthicum, Ord. Res.,
care of Security Bank & T. Co., Greenwood, Miss.
Capt. Thomas E. Moon, Ord. Res.,
250 South Madison Ave., Congress Park, Ill.
Capt. Harry E. Rogers, Ord. Res.,
50 Lewis Place, St. Louis, Mo.
Capt. Ralph W. Smith, Ord. Res.,
804 Hellman Bank Bldg., Los Angeles, Calif.
Capt. Fred L. Summerfield, Ord. Res.,
Ordnance Department, Fort Myer, Va.
Capt. Francis J. Thomas, Ord. Res.,
Strathmore Paper Co., Mittineague, Mass.
1st Lieut. John S. Carter, Ord. Res.,
654-A Main St., Melrose, Mass.
1st Lieut. Francis J. G. Dorsey, Ord. Res.,
7021 Torresdale Ave., Tacony, Phila., Pa.
1st Lieut. Donald C. Fabel, Ord. Res.,
11428 Carolina Road, Cleveland, Ohio.
1st Lieut. David L. Fiske, Ord. Res.,
110 Transportation Bldg., Urbana, Ill.
1st Lieut. Harry Geist, Ord. Res.,
1001 President St., Brooklyn, N. Y.
1st Lieut. James H. Hoffnagle, Ord. Res.,
Room 2809, 14 Wall St., New York, N. Y.
1st Lieut. Timothy N. Holden, Jr., Ord. Res.,
1219 Glenwood Road, Brooklyn, N. Y.
1st Lieut. Richard Kent, Ord. Res.,
727 N. Main St., West Lafayette, Ind.
1st Lieut. Frederick J. Lanz, Ord. Res.,
281 Wadsworth Ave., New York, N. Y.
1st Lieut. Graham I. Lynch, Ord. Res.,
408 Lee St., Clarksburg, W. Va.
1st Lieut. John B. Mackenzie, Ord. Res.,
4609 Westminster Place, St. Louis, Mo.
1st Lieut. Kenneth C. Monroe, Ord. Res.,
1855 Main St., Stratford, Conn.
1st Lieut. George A. Moshchansky, Ord. Res.,
Bucyrus Company, South Milwaukee, Wis.
1st Lieut. George A. Sheller, Ord. Res.,
109 West 88th St., New York, N. Y.
1st Lieut. George E. Smith, Ord. Res.,
25 Dey St., New York, N. Y.

1st Lieut. Rudolph J. Thanisch, Ord. Res.,
200 Bellevue St., West Roxbury, Mass.
1st Lieut. Oscar H. Wetherby, Ord. Res.,
430 South Occidental Blvd., Los Angeles, Calif.
1st Lieut. Harry A. Wilson, Ord. Res.,
3015 Calhoun Blvd., Minneapolis, Minn.
2nd Lieut. Huntley M. Campbell, Ord. Res.,
108 Vincent St., Alliance, Ohio.
2nd Lieut. Frank W. Chambers, Ord. Res.,
2136 Oregon St., Berkeley, Calif.
2nd Lieut. Charles R. Currier, Ord. Res.,
1120 Board of Trade Bldg., Portland, Ore.
2nd Lieut. William H. Gerretsen, Jr., Ord. Res.,
Box 689, Roseburg, Ore.
2nd Lieut. Richard E. Grimsley, Ord. Res.,
441 Pennsylvania Ave., Denver, Colo.
2nd Lieut. Arthur B. Hansen, Ord. Res.,
310 A St. N. E., Washington, D. C.
2nd Lieut. Norman E. Haskell, Ord. Res.,
P. O. Box 302, Waterville, Maine.
2nd Lieut. William A. Jolley, Ord. Res.,
P. O. Box 259, Phoenix, Ariz.
2nd Lieut. Charles H. McCann, Ord. Res.,
3 Briggs St., North Adams, Mass.
2nd Lieut. John H. Mills, Ord. Res.,
337 N. Maple Ave., East Orange, N. J.
2nd Lieut. John F. Ohlson, Ord. Res.,
81 North 18th St., East Orange, N. J.
2nd Lieut. Gerald L. Parker, Ord. Res.,
128 Webster St. N. W., Washington, D. C.
2nd Lieut. Sidney Quinby, Ord. Res.,
632 Brandywine Ave, Schenectady, N. Y.
2nd Lieut. William O. Reitz, Ord. Res.,
178 North Pickering St., Brookville, Pa.
2nd Lieut. John H. Roberts, Ord. Res.,
731 Humboldt St., Denver, Colo.
2nd Lieut. Arville V. Sanders, Ord. Res.,
R. R. A. Cache, Okla.
2nd Lieut. Robert J. Shipp, Ord. Res.,
34 Main St., Newton, N. C.
2nd Lieut. Robert J. Sloan, Jr., Ord. Res.,
195 Clifton Place, Syracuse, N. Y.
2nd Lieut. George R. Smith, Ord. Res.,
312 S. 3rd St., Albuquerque, N. Mex.
2nd Lieut. William S. Weikel, Ord. Res.,
41 N. Wendell Ave., Schenectady, N. Y.
2nd Lieut. Walter E. Wickstrom, Ord. Res.,
54 Holden St., Worcester, Mass.
2nd Lieut. Frank L. Young, Jr., Ord. Res.,
32 Linden Ave., Ossining, N. Y.

Recently Assigned Ordnance Reserve Officers

THE following reserve officers have recently been assigned as indicated after their names:

Col. Ledyard Cogswell, Jr., Ord. Res., Manufacturing Service, Buffalo District Ordnance Office, Watervliet Arsenal, Watervliet, N. Y.

Col. Bruce Cornwall, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

Lieut. Col. Page S. Bunker, Ord. Res., Territorial Assignment Group.

Lieut. Col. George E. Carpenter, Ord. Res., Territorial Assignment Group.

Lieut. Col. Theodore J. Hoover, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

Lieut. Col. Gilbert P. McNiff, Ord. Res., Manufacturing Service, Pittsburgh District Ordnance Office, Pittsburgh, Pa.

Lieut. Earle B. Norris, Ord. Res., Manufacturing Service, Artillery Division, Washington, D. C.

Major Edward M. Ayer, Ord. Res., Manufacturing Service, Ammunition Div., Washington, D. C.

Major A. Linton Bausman, Ord. Res., Manufacturing Service, Bridgeport District Ordnance Office, Springfield Armory, Springfield, Mass.

Major Elmer J. Bryant, Ord. Res., Manufacturing Service, Executive Section, Washington, D. C.

Major Lindsley M. Brown, Ord. Res., Manufacturing Service, St. Louis District Ordnance Office, San Louis, Mo.

Major James F. Carle, Ord. Res., Manufacturing Service, U. S. Nitrate Plant, Muscle Shoals, Ala.

Major Almon W. Copley, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

Major Lyman M. Dawes, Ord. Res., Manufacturing Service, Boston District Ordnance Office, Boston, Mass.

Major Jules Dierckx, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

Major Howard W. Dix, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

Major John Edwards, Ord. Res., Territorial Assignment Group.

Major Don H. Foster, Ord. Res., Field Service, Facilities Section, Washington, D. C.

Major Robert L. Fulton, Ord. Res., Territorial Assignment Group.

Major Charles O. Gunther, Ord. Res., Manufacturing Service, Small Arms Division, Washington, D. C.

Major Adolph W. Lissauer, Ord. Res., Manufacturing Service, Cincinnati District Ordnance Office, Cincinnati, Ohio.

Major Frederick D. McLaughlin, Ord. Res., Manufacturing Service, Cleveland District Ordnance Office, Cleveland, Ohio.

Major Charles F. Morley, Ord. Res., Manufacturing Service, Buffalo District Ordnance Office, Watervliet Arsenal, N. Y.

Major Frank L. Peterson, Ord. Res., Manufacturing Service, Tank, Tractor, and Trailer Division, Washington, D. C.

Major Ambrose E. Ridenour, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

Major William L. Sayers, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

Major Robert A. Smith, Ord. Res., Manufacturing Service, Picatinny Arsenal, Dover, N. J.

Capt. Robert E. Baker, Ord. Res., Manufacturing Service, Pittsburgh District Ordnance Office, Pittsburgh, Pa.

Capt. Walter C. Bender, Ord. Res., Manufacturing Service, Rock Island Arsenal, Rock Island, Ill.

Capt. Arthur D. Champlin, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York N. Y.

Capt. Paul A. Curtis, Jr., Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

Capt. Walter H. Damon, Ord. Res., Mfg. Service, Chicago Dist. Ord. Office, Chicago, Ill.

Capt. Charles W. Francis, Ord. Res., Manufacturing Service, Cleveland District Ordnance Office, Cleveland, Ohio.

Capt. Hally Fox, Ord. Res., Technical Staff, Aberdeen Proving Ground, Md.

Capt. Wilbur M. Jefferys, Ord. Res., Field Service, Ammunition Supply Division, Washington, D. C.

Capt. Arthur F. Hubbard, Ord. Res., Manufacturing Service, Ammunition Division, Washington, D. C.

Capt. Daniel A. Linthicum, Ord. Res., Territorial Assignment Group.

Capt. Harold K. McCook, Ord. Res., Manufacturing Service, Frankford Arsenal, Phila., Pa.

Capt. William M. Moody, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

Capt. Thomas E. Moon, Ord. Res., Manufacturing Service, Chicago District Ordnance Office, Chicago, Ill.

Capt. Barrett Rogers, Ord. Res., Manufacturing Service, Chicago District Ordnance Office, Chicago, Ill.

Capt. Harry E. Rogers, Ord. Res., Manufacturing Service, St. Louis District Ordnance Office, St. Louis, Mo.

Capt. Austin D. Smith, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

Capt. Fred L. Summerfield, Ord. Res., Territorial Assignment Group.

1st Lieut. Francis J. G. Dorsey, Ord. Res., Manufacturing Service, Philadelphia District Ordnance Office, Philadelphia, Pa.

1st Lieut. Donald C. Fabel, Ord. Res., Manufacturing Service, Cleveland District Ordnance, Office, Cleveland, Ohio.

1st Lieut. Harry Geist, Ord. Res., Territorial Assignment Group.

1st Lieut. James H. Hoffnagle, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

1st Lieut. Claude S. Kegerreis, Ord. Res., Manufacturing Service, Tank, Tractor and Trailer Division, Washington, D. C.

1st Lieut. Frederick J. Lanz, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

1st Lieut. Graham I. Lynch, Ord. Res., Territorial Assignment Group.

1st Lieut. John B. Mackenzie, Ord. Res., Territorial Assignment Group.

1st Lieut. George A. Sheller, Ord. Res., Territorial Assignment Group.

1st Lieut. George E. Smith, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

1st Lieut. Rudolph J. Thanisch, Ord. Res., Territorial Assignment Group.

1st Lieut. Oscar H. Wetherby, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

1st Lieut. Harry A. Wilson, Ord. Res., Manufacturing Service, Chicago District Ordnance Office, Chicago, Ill.

2nd Lieut. Frank W. Chambers, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

2nd Lieut. William H. Gerretsen, Jr., Ord. Res., Territorial Assignment Group.

2nd Lieut. Richard E. Grimsley, Ord. Res., Territorial Assignment Group.

2nd Lieut. Norman E. Haskell, Ord. Res., Territorial Assignment Group.

2nd Lieut. Charles B. Janes, Ord. Res., Manufacturing Service, Aircraft Armament Division, Washington, D. C.

2nd Lieut. George G. Jones, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

2nd Lieut. William A. Jolley, Ord. Res., Territorial Assignment Group.

2nd Lieut. Frederick B. McNeil, Ord. Res., Manufacturing Service, St. Louis District Ordnance Office, St. Louis, Mo.

2nd Lieut. John H. Mills, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.

2nd Lieut. John F. Ohlson, Ord. Res., Manufacturing Service, Ammunition Division, Washington, D. C.

2nd Lieut. Ernest F. Page, Ord. Res., Technical Staff, Aberdeen Proving Ground, Md.

2nd Lieut. Gerald L. Parker, Ord. Res., Manufacturing Service, Baltimore District Ordnance Office, Baltimore, Md.

2nd Lieut. William O. Reitz, Ord. Res., Territorial Assignment Group.

2nd Lieut. John H. Roberts, Ord. Res., Territorial Assignment Group.

2nd Lieut. Arville V. Sanders, Ord. Res., Territorial Assignment Group.

2nd Lieut. Robert J. Shipp, Ord. Res., Territorial Assignment Group.

2nd Lieut. Robert J. Sloan, Jr., Ord. Res., Manufacturing Service, Buffalo District Ordnance Office, Watervliet Arsenal, Watervliet, N. Y.

2nd Lieut. George R. Smith, Ord. Res., Territorial Assignment Group.

2nd Lieut. Orion O. Smith, Ord. Res., Manufacturing Service, Chicago District Ordnance Office, Chicago, Ill.

2nd Lieut. William S. Weikel, Ord. Res., Territorial Assignment Group.

2nd Lieut. Frank L. Young, Jr., Territorial Assignment Group.

Professional Notes

AMMUNITION DIVISION

The Muscle Shoals Commission

MEMBERS of the Army Ordnance Association will be interested in the recent action by Congress in authorizing the appointment of a commission by the President to investigate the most practical method of utilizing the facilities at Muscle Shoals. The resolution as passed by the House and concurred in by the Senate stated, "It is the sense of the House of Representtatives of the United States in Congress assembled that the President create a Muscle Shoals Commission of three members comprised of a representative citizen familiar with the Muscle Shoals enterprise, a representative of agriculture versed in the use of commercial fertilizers, and a chemical engineer versed in the methods of air nitrogen fixation." The commission, under the resolution, is to report to the President who will lay his recommendations before Congress at the beginning of the next session.

The resolution provides further, "*Resolved*, That the President be, and is hereby, requested to secure, through the commission such information as in his judgment is necessary or desirable in order to determine the best, cheapest and most available means for the production of nitrates in accordance with said sec. 124 of the National Defense Act, with particular reference to the properties acquired by the United States under said section 124 at Muscle Shoals, Alabama. In order to obtain information making it possible to determine definitely the best, cheapest, and most available means for the production of nitrates, the President is requested through the commission to ascertain the most favorable conditions under which this property may be leased, primarily to secure nitrates for fertilizers in time of peace and explosives in time of war, and to lay all of his information, together with his recommendations, before Congress at the beginning of the next session."

Pursuant to this act of Congress, the President has appointed the following gentlemen to serve on the commission:

John C. McKenzie, former Representative from the Thirteenth Congressional District of Illinois, who will serve as chairman. Mr. McKenzie was born on a farm in 1860 and has been identified with state and national politics for some time and was chairman of the House Committee on Military Affairs, in which capacity he was an ardent advocate of the acceptance of the Ford offer. He has been opposed to government operation of Muscle Shoals.

N. B. Dial, former Senator from South Carolina, was born in 1862 and attended Richmond College and Vanderbilt University. In 1882-83 he took a course in law at the University of Virginia. He has been identified with farming interests, banking, manufacturing, hydroelectric power plants, and with many political activities. Although he showed his individualism in the last session of Congress, he has not been so active with the Muscle Shoals question as has Mr. McKenzie.

Harry A. Curtis is the chemical engineer of the commission. He was born in 1884 and holds degrees from the Universities of Colorado and Wisconsin. He was for some years on the staff of the University of Colorado, was with the Nitrate Division of Army Ordnance 1917-19, professor of chemistry at Northwestern University, and then identified with the International Coal Products Corporation as chief chemist, and later superintendent of the Irvington, N. J., plant. He then became general manager of the Clinchfield Carbocoal Corporation, and was afterwards chief of the Nitrogen Survey of the Department of Commerce. He is now professor of chemical engineering at Yale, and serves as consultant to the Department of Agriculture in connection with research on fertilizers.

William McClellan, a consulting electrical engineer of New York, was born in 1872. He has been an engineer with Westinghouse, Church, Kerr & Company, a member of other consulting firms, and is now president of McClellan & Junkersfeld, Inc. He was consulting engineer for the Public Service Commission of the Second District of New York in 1911-13, dean of the Wharton School, University of Pennsylvania, 1916-19. He has been identified with many scientific organizations, having been president of the American Institute of Electrical Engineers 1921-22. His opinions regarding Muscle Shoals are not known, but power interests seem to place great faith in his influence upon the commission in arriving at a sound discussion of the Muscle Shoals facts.

Russell F. Bower of the Farm Bureau Federation, born in 1885, is a graduate of Wesleyan University. He has been identified with the possible use of Muscle Shoals for fertilizer purposes since 1916, when he was active in connection with the National Defense Act. His record indicates that he is a strong believer in the utilization of Muscle Shoals primarily for the development of better and cheaper fertilizers. Mr. Bower was associated with Mr. Curtis in the Nitrogen Survey of the Department of Commerce, and is the representative of the American Farm Bureau Federation and its interests upon the commission.

While the commission is investigating the situation, plans have been made by the War Department to begin the operation of four units of the plant, capable of producing 100,000 horsepower, by January 1st unless such action is not in conformity with the views of the commission. The first hydroelectric unit at Muscle Shoals will be completed between July 1st and August 1st and it is intended to place at the disposal of bidders the power generated by this unit with the understanding that the contract for its distribution shall be awarded to one

individual or corporation. Work is rapidly progressing on three other units which will be ready for operation by January 1st, 1926.

Acting Secretary of War, Dwight F. Davis, has advised the chairman of the Muscle Shoals Commission that upon completion of the first unit it will be necessary to put it in operation at once to test out the machinery and make necessary adjustments. In his letter to the Commission Mr. Davis stated that the Department would proceed with the operation of the first unit in July and the three other units in January unless Chairman McKenzie and his associates decide that such operation would interfere with their deliberations. Mr. Davis advised that certain conditions should be borne in mind in connection with temporary consumption of power at Muscle Shoals, principally that such operation would not interfere with construction work and that awards should be made under a revocable license so that the arrangement might be terminated at any time to conform to legislation by Congress. The Acting Secretary also said that in the temporary operation of the plant it would be impracticable to have more than one contractor purchase power. As the output is to be limited, he suggested that it would not be easy to devise a plan for its division among a group of contractors.

The first executive session of the Commission was held April 9th, at which time it was decided to visit the project on a date to be determined later. Acting on the President's suggestion, the Commission communicated with representatives of the War Department on behalf of which Acting Secretary Davis appeared and urged an adequate supply of nitrates as a national defense measure. Dr. E. D. Ball, director of scientific work, and Dr. F. G. Cottrell, director of the Fixed Nitrogen Laboratory, representing the Department of Agriculture, also appeared at this meeting and emphasized the need for adequate production of fertilizer. Secretary Hoover also promised his cooperation.

It is hoped by all advocates of national defense that the work now under way by the Commission will lead to a final and satisfactory solution of this post-war problem which has been the source of much discussion since the Armistice. Industrial preparedness advocates will look forward to the results of the Commission's deliberation with keen anticipation.

ARTILLERY DIVISION

New Navy 5-Inch Gun

ACCORDING to recent press dispatches released through the Navy Department, Washington, D. C., the ordnance engineers of the Navy have completed the design and manufacture of a new 5-inch antiaircraft gun, several of which are ready for installation on the larger ships. The present Navy 3-inch guns have a vertical range of 8,000 yards, or 4 nautical miles, as compared with the new rifle which has a range of 20,000 yards. The new gun also takes an increased bursting charge over that used by the 3-inch weapon. It has a simplified method of serving the gun with ammunition so that, it is estimated, properly trained crews can fire the piece at the rate of one shot every four seconds. This rapid fire feature will add materially to the effectiveness of the gun and will act in an antiaircraft capacity similar to tracer ammunition used with machine guns and other small arms.

An additional claim for the new gun is that the ammunition which accompanies it has an increased bursting area which is more than treble that of the 3-inch piece thereby adding to the dispersion of burst and thus materially aiding its antiaircraft possibilities. It is also stated that a new system of fire control equipment has been installed on the gun which will permit operation of the weapon with a machine-like rapidity.

The first increment of these weapons to be installed will be placed upon battleships and cruisers. It is not believed likely that they will supplant the present 3-inch guns on destroyers due to the fact that the gun platforms of these smaller vessels will not be able to withstand the recoil of the new gun.

Concerning recent antiaircraft target practice conducted by the Navy Department, from ships on the West Coast it is reported that fire with the 3-inch guns was quite successful. They were trained aginst sleeve targets towed by airplanes, the actual targets being about one-half the size of the fusilage of the plane. One of the reports received by the Navy Department says that except on the first practice shot all other bursts were either slightly ahead of the sleeve or immediately upon it. One shell was seen to pierce the sleeve in direct flight and burst just beyond. It is said that the new 5-inch guns are all ready for installation and that upon the return of the Fleet from its present practice maneuvers those now available will be installed.

American Railway Artillery

THE design of railway artillery was actively taken up in the year 1914 in the Ordnance Office. The Board of Review which was appointed by the Secretary of War to make definite recommendations in regard to the armament for our seacoast fortifications, recommended that an appropriation be asked of Congress for the construction of six 16-inch movable howitzers and an experimental 14-inch gun on railway car mount for defense against hostile landing in unfortified harbors.

As a result of these recommendations the Ordnance Department undertook the design and construction of the 16-inch howitzer railway mount, model E, and the 14-inch gun railway mount, model E. The 14-inch gun railway mount, model E, was under construction at the outbreak of the War, at Watertown Arsenal. As this railway mount was designed especially as a seacoast defense weapon, the work was given a low priority so that it was not completed until October 19, 1918. This mount was sent to the Aberdeen Proving Ground and given a thorough test. It was then forwarded to Fort Story, Va., where it was tested by the Coast Artillery Board. The Coast Artillery Board's report was very favorable in general; the Board making a number of specific recommendations concerning modifications which were desired. The greatest fault appeared to be the slow rate of fire due to elevating and depressing a gun of this size by hand and handling the ammunition from the ammunition car up to the level of the loading platform by hand power. The 16-inch howitzer railway mount, model E, being also designed especially for seacoast purposes was set aside for more important work during the War and was not completed until July 30, 1919. This howitzer was tested at the Aberdeen Proving Ground and found to be fairly

satisfactory. The large casting which formed the foundation for this howitzer was not considered to be of the best possible type and railway mounts developed during the World War had more satisfactory characteristics.

The railway mounts designed during the World War were mainly only suited for use against fixed targets since the mounts or their emplacements would only permit limited fire. Due to the fact that only a relatively small number of rounds would be fired each day very little attention was given to the design of the loading equipment so that most of the mounts designed during the period of the World War could only be fired at a rate of one shot every two to four minutes. Of the railway mounts mentioned above only the 7-inch gun, railway mount, 8-inch gun, railway mount, model 1918; 12-inch mortar railway mount, model 1918; 14-inch gun, railway mount, model E; and 16-inch howitzer, railway mount, model E, permitted all-around fire. All other mounts were limited in traverse to 5 to 10°.

Post-War Activities

The Westervelt Board report which has formed the program for the development of Ordnance matériel since the World War, specifies as follows in connection with the development of railway artillery:

"Super guns. In the designs of all artillery of this class, it is essential that the seacoast defense problem be considered, since this type of artillery should be suitable not only for use in the field, but also for use along our coast against naval targets. For this reason, all carriages should be provided with means of obtaining all-around fire, either from a position previously prepared, or from a temporary platform. This feature of all-around fire in the case of large guns and howitzers, will doubtless be in addition to the regular means provided for firing the mount in the field against the stationary target. The design of the carriages should be studied with the view of obtaining a universal Barbette mount that could be emplaced in the present seacoast emplacements, in simple auxiliary emplacements and with trucks under it forming a railway mount."

The Board further specifies the following calibers for railway artillery:

8-inch 50 caliber gun on railway carriage:
Elevation 0 to 50°
Horizontal arc of fire 56°
Weight of projectile 240 lbs.
Maximum range 35,000 yds.

12-inch 20 caliber howitzer on railway carriage:
Vertical arc of fire 25 to 60°
Horizontal traverse 360°
Weight of projectile 700 lbs. or 1046 lbs.
Maximum range 25,000 yds.

14-inch 50 caliber gun on railway mount:
Vertical elevation 0 to 50°
Horizontal traverse 360°
Weight of projectile 1,400 lbs.
Maximum range 40,000 yds.

16-inch 25 caliber howitzer on railway mount:
Elevation 25 to 65°
Horizontal traverse 360°
Weight of projectile 1,600 lbs.
Maximum range 30,000 yds.

The 14-inch gun railway mount, model 1920, was designed to meet the general specifications of the Westervelt Board. The first carriage has been tested at the Aberdeen Proving Ground. All firing tests have been completed. A number of mechanical defects were found in the carriage which are being overcome by suitable modifications. It was found by actual trial that the mount could be fired at a rate of one shot per minute, being in this respect equivalent to the latest type of fixed armament. The 14-inch gun railway mount, model 1920, can be placed on a semipermanent concrete platform for use against moving naval targets. This platform provides all-around fire. A 150 h. p. Sterling engine has been mounted on the front truck directly connected with a 50 k. w. generator. This power plant furnishes all electrical power for traversing the mount, elevating the gun, raising ammunition from the ground to the level of the loading platform, compressing air for the elevation of the breech block and for gas ejection, and furnishes current for electric lights required for night firing. This mount can also be fired directly from the railway track with very little preparation. In this case 7° traverse can be obtained by moving the gun on its carriage. Additional traverse can be obtained by operating the mount on a curved track. The carriage would therefore be satisfactory not only as a seacoast defense weapon, but also for use in the field with an army. The mount was run down from Watertown Arsenal to the Aberdeen Proving Ground on its own wheels and no difficulties were experienced.

The 16-inch 25-caliber howitzer designed for seacoast defenses can also be mounted on this same railway mount. It was found that the weight of the 16-inch howitzer was so near that of the 14-inch gun as to make it possible to mount the 16-inch howitzer on the same carriage. This has been done. It is only necessary to remove the 14-inch gun and its cradel and substitute the 16-inch howitzer and its cradle.

The Westervelt Board as stated above calls for a 12-inch 20-caliber howitzer. The 12-inch 20-caliber howitzer railway mount, model 1918, was designed to meet this requirement. The chararteristics of this mount are as follows:

Caliber of gun 12″
Muzzle velocity 1,950 f. s.
Range 22,000 yds.
Elevation 20° to 60°
Traverse 360°

This railway mount has been so designed as to permit the howitzer being fired through a horizontal arc of 360°. A very simple type of ground platform is used so that the mount can be put in position in about a half hour's time. Special loading facilities are provided so that a rate of fire of one shot a minute can be maintained using hand appliances.

The 12-inch 20-caliber howitzer railway mount, model 1918, has been tested at the Aberdeen Proving Ground and found to be satisfactory. Some difficulty has been encountered due to the instability of the mount when firing at 20° elevation and 45° traverse with the track. This difficulty can be remedied by increasing the length of the outriggers and increasing the size of the outrigger floats. When this is done the mount can be considered as satisfactory for the purposes for which it was designed. It is intended to turn this mount over to the Coast Artillery Board for test later.

8-INCH GUN RAILWAY MOUNT PROJECT

It was found that the 8-inch 50-caliber gun weighed about the same as the 12-inch 20-caliber howitzer so that these two weapons could be mounted on the same carriage. In designing the 12-inch 20-caliber howitzer railway mount provision was therefore made for mounting an 8-inch gun. An 8-inch 50-caliber gun was designed but none was built due to lack of funds. A cradle has been designed which will permit the 8-inch naval gun to be mounted on the 12-inch 20-caliber howitzer railway mount. The manufacture of one cradle has recently been approved by the Technical Staff and an order will be placed with the Watertown Arsenal at an early date. When completed range firings will be held at the Aberdeen Proving Ground to determine the maximum range and the dispersion of the Navy 8-inch gun. It is expected that a maximum range of about 35,000 yards can be obtained. Unless our fortifications are provided with high-power intermediate caliber guns, it will be necessary to use major caliber high-power guns against light cruisers mounting high-power intermediate caliber guns.

SMALL ARMS

Winchester Model 95 With Asiatic Expedition

POSSIBLY because of the travels of the late Colonel Roosevelt into Africa and South America and the interest he created in these expeditions the trip of his sons Theodore and Kermit and George K. Cherry into Chinese Turkistan is attracting unusual interest and the public will watch carefully to note the results of the younger Roosevelts. The idea of this trip to "the top of the world" originated with the late President and the boys are carrying out plans their father had in mind.

By now the trio and their native helpers are in the Himalayan wilds searching for the Ovis Poli, said to be the great great grandfather of all mountain sheep, and the long haired tiger, which they expect to find in the jungles at the bottom of the Tian Shan mountains. The party may be back in three months, it may be six, or it may be longer. After they get through the pass there is no telling just when they will return.

The expedition was fitted out in the interests of science by James Simpson, General Manager of Marshall Field Company in behalf of the Field Museum and in consequence is known as the Simpson-Roosevelt-Field Museum Expedition. The Roosevelt boys and 60 year old, white haired, mild mannered George Cherry, the naturalist, are the only white men in the party. He was with President Roosevelt on his African and Brazilian expeditions and has also made 38 exploring trips into Central and South America and the West Indies. This is the same Cherry who one evening 20 odd years ago in the upper reaches of the Orinoco in Venezuela dropped his scientific tools and with 20 men of the anti-Castro faction drove a Government General and 400 soldiers out of town so fast that the General fled in his pajamas. He is a man of steel nerves, the kind of nerves that the present tour requires.

It is a coincidence that the names of those on this expedition are the same as on the tours to Africa and South America only the Theodore Roosevelt in this instance is the son and not the father.

Besides the Ovis Poli and the long haired tiger the party is seeking the great Ibex, the markor, a giant specimen of mountain goat, the Yarkand stag and the goitered gazelle. To secure some of these the explorers will find it necessary to go into places where no white man has ever been. Kipling is quoted as saying of the country that "every mile stands on end." Explorers know it as "the top of the world." The mountain passes are 15,000 and more feet above sea level, seldom does one see timber, the country is bleak and barren, and it can be summed up as the highest, wildest, and most barren spot in the world.

Gathering the native bearers at Srinigar in the Vale of Kashmir, at the Northwestern extreme of India, the party goes through the hazardous Leh Pass, the mail route to Tibet, between Afghanistan and Tibet, to reach the Pamir Plateau, where they expect to find the Ovis Poli. From here the party will proceed through Chinese Turkistan to the Tian Shan range. Leh Pass is open only in the summer months and during the thaws the threat of avalanches and floods are always present. Much of the travel, especially in the pass, will be done at night, as the piercing cold that comes with the sinking of the sun will check the thaw and there will be less danger from snow slides. It is unlikely that the party can travel more than one mile an hour. In many places they will have to cut their steps with axes to make upward progress. From this you will gather that the trip involves great hardships and is not altogether lacking in danger.

Reaching their destination and securing their game the movements of the party must be hurried for Leh Pass will again be filled with snow in September. Unless the party returns through the pass before then they will have the choice of being marooned in a country of rock and ice, or of working their way to civilization by a torturous journey through Mongolia and Siberia. They should have a remarkable story to tell when they return.

The Rooseevlt's took with them four model 95-405 Winchesters and 1000 rounds of 405 Winchester soft point cartridges. The game they are apt to find will be big and will have to be killed from a distance.

The model 95 Winchester was the first box magazine lever action rifle ever put on the market. It offers many advantages in rapidity of action. As a single loader it can be fired 25 times in a minute. As a repeater it can be fired three times a second. The barrels are of nickel steel and are of special design so that they may

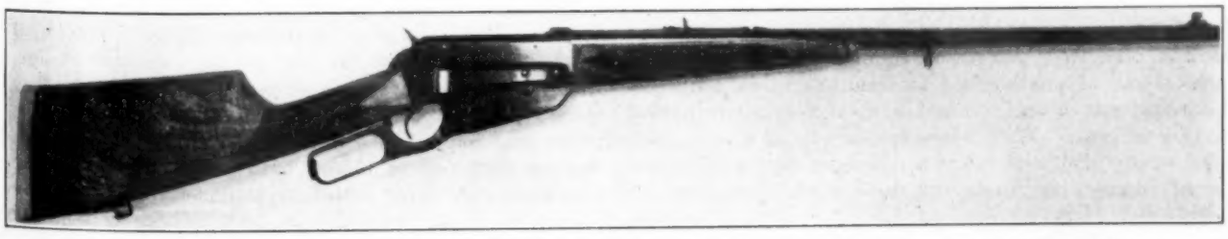


Fig. 1. One of the Winchester 95-405 Rifles Made for Col. Theodore Roosevelt and Taken on Asiatic Expedition

withstand the extraordinary strain necessary in a rifle designed to handle the powerful cartridge for which the model 95 is chambered.

The weight of this bullet is 300 grains. It has a muzzle velocity of 2198 feet per second at the muzzle and at 100 yards the velocity is 1923 feet per second. The energy of the bullet at the muzzle is 3218 foot pounds and at 100 yards 2464 foot pounds. The cartridge will pentrate 13 inches through 7/8-inch soft pine boards at 15 feet.

The Roosevelt rifles have specially constructed stocks. Each required 10 hours to make, being built exactly like those made for the elder Roosevelt. They are of American black walnut with a cheek piece and recoil pad, 14 1/8 inches long with a drop of 2 1/8 inches at the heel, 1 1/2 inches at the comb and with a trigger pull of five pounds. There is a Lyman ivory bead front sight and sporting rear sight with platinum line.

PETER P. CARNEY.

PICATINNY ARSENAL

Methods Used by the Germans in Loading High Explosive Shell

PRIOR to the World War the customary method employed by the Germans in loading high explosive shell was based on the use of hard paper cartons or envelopes which completely enclosed the explosive charge. The use of such cartons was inaugurated about 1888 when picric acid was adopted as the standard filler for shell. The purpose of the cartons was originally to prevent the ready reaction which would take place between picric acid and the metal comprising the shell wall. Although very little picric acid was used during the War as a shell filler, the carton method of loading was still used extensively as it was considered to have other advantages besides that of preventing corrosion of the shell walls. While TNT was usually loaded by casting the molten material directly into the shell, several of the substitute fillers which were brought into use possessed such severe toxic properties that workmen were scarcely able to withstand the exposure attending the casting of such materials. This was true in case of both dinitrobenzol and trinitroanisole which were the principal substitutes for TNT. Difficulty in holding workmen at the shell-filling plants where these explosives were used, finally led to the practice of loading the materials into cartons for large caliber shell. Since the cartons were filled at the plants manufacturing the explosives, the operation at the loading plant did not necessitate contact of the workmen with the explosive. While of course the problem still existed at the manufacturing plant, the number of workmen there was comparatively small and by taking special precautions they could be protected better than at the loading plants.

Although no information is available to indicate that such was the case, it is suggested that another purpose for using the carton method of loading was that the method permitted the retention, during peace time, of large stocks of unassembled ammunition which could be assembled and brought into use upon very short notice in case of war. With a reserve supply of loaded cartons, empty shell and other components, and a complete set of instructions as to the method of assembling, it would really require only a few days notice to start a flow of the finished ammunition from the artillery depots to the front. By storing the explosive and the metal components separately during peace time, the deterioration which was almost certain to occur with loaded shell during storage, such as exudation, corrosion of the shell walls, absorption of moisture, etc., would be entirely eliminated. Thus, while the carton method of loading might offer advantages from the standpoint of holding large quantities of ammunition in readiness for war, this advantage would disappear after a war was well under way and the production of explosives and ammunition had been brought to the point that it would satisfy the current demand. As a matter of fact for some time before the close of the War carton loading was discontinued except in case of explosives having poisonous properties.

As implied above, the general scheme followed in loading shell by the carton method involved the loading of the cartons at the various plants manufacturing the explosives; the cartons were then transported to the artillery depots which also received from the respective manufacturing plants all other components, such as shell, boosters, fuzes, etc., necessary for the complete assembly of high explosive ammunition.

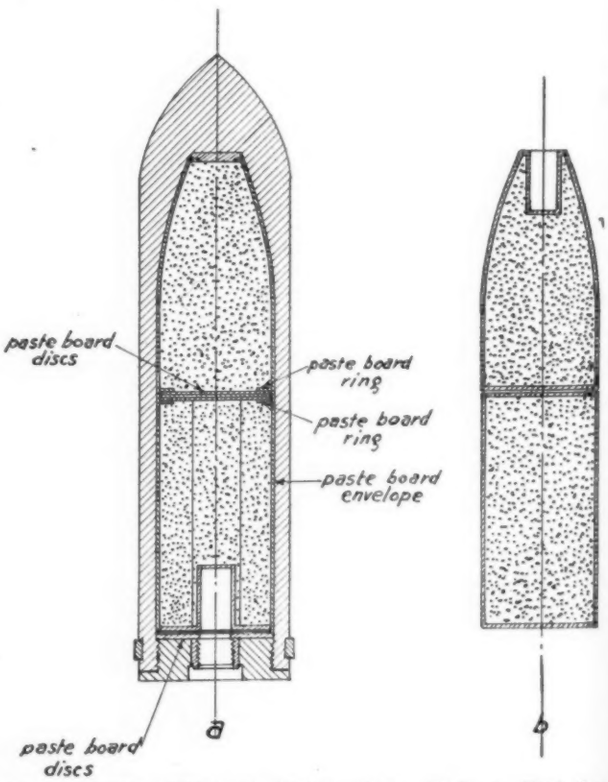


Fig. 2. Carton Method of Loading 21-cm. Shell as Used by Germans

The material used in making the cartons was a very stiff cardboard, ranging in thickness from 1 mm. to 3 mm., depending upon the size of the explosive charge. In order to protect the envelopes against moisture they were either covered with a coating of shellac or the paper was impregnated with petroleum pitch. For the smaller shell (up to 15 cm. with a few exceptions) the envelopes were made with outside dimensions practically

the same as the dimensions of the shell cavity into which they were to be placed. In loading, the envelopes were placed in forms and the explosive charge cast or pressed into them, after which they were closed by means of pasteboard rings and discs which were cemented tightly together with magnesia cement. The carton with its explosive charge was then labelled as to the type of the

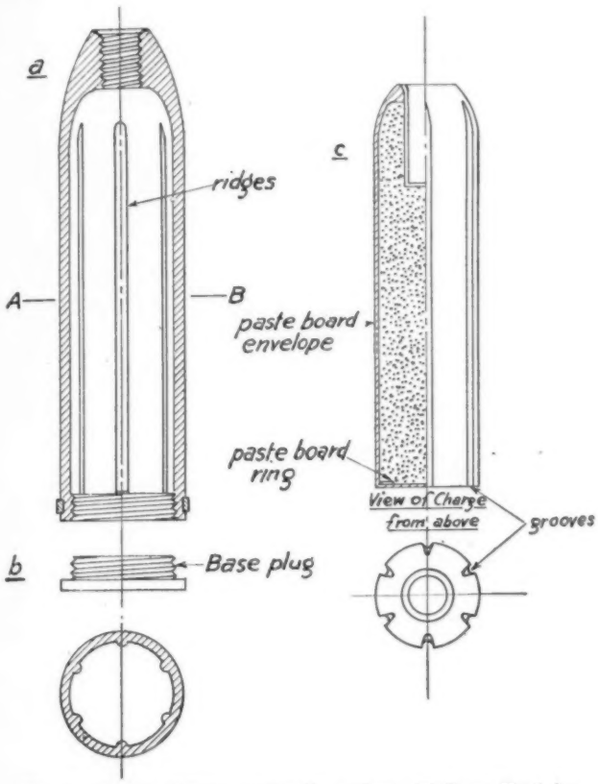


Fig. 3. Carton Method of Loading 15-cm. Shell as Used by Germans

explosive and the type of shell with which it was to be used.

For shell larger than 15 cm. and also the longer types of shell smaller than 15 cm., the charge consisted of two distinct portions, the "*Oberteile*" and the "*Unterteile.*" These were separate cartons which might or might not contain the same kind of explosive. Fig. 2-a shows a longitudinal cross section of a 21-cm. base-detonating shell loaded with a charge in two separate portions. Fig. 2-b shows the two portions of a charge for a 21-cm. point-detonating shell.

In order to load shell with cartons of this sort it was of course necessary to have the shell provided with removable heads or removable bases regardless of whether they were to be point-fuzed or base-fuzed. Several types of German shell had removable heads. Fig. 3-a shows a split 15-cm. *point*-detonating shell with removable base plug. On the inside wall of shell of this type were six ridges about 5 mm. high and 14 mm. wide, running from the point to the base of the shell. The explosive charge or carton shown in Fig. 3-c had grooves corresponding in dimensions to the ridges on the interior wall of the shell. In loading, the grooves of the loaded carton were fitted precisely over the ridges. In order to prevent any movement of the charge forward or backward in the shell, discs of very hard pastboard were placed at the base of the shell until all space was completely filled. In addition the charge was made firm within the shell by pouring magnesia cement, paraffin, or a paraffin-talcum mixture into all empty spaces around the cartons after they were placed in position. The magnesia cement was considered the most desirable material for making the charge firm but it had the disadvantage that it was almost impossible to unload a shell after the cement had once hardened. When the paraffin or paraffin-talcum mixture was used the shell could be unloaded in case of necessity by simply heating them sufficiently to melt the paraffin and then allowing the cartons to slide out.

There was always, at the artillery depots, a force engaged in overhauling the remainder of certain lots of shell which were considered suspicious because of prematures, etc. Hence the advantage of using a cement that would permit a comparatively simple method of unloading the charges from the shell. In using the paraffin-talc mixture to cement the cartons in place the mixture was heated to about 80°C at which temperature it could be readily poured into the shell. The shell was then warmed before the carton of explosive was introduced in order to keep the paraffin-talc mixture from cooling too quickly to a solid mass before the loading operation was completed.

In order to indicate the details of the operation of loading shall with cartons the following translation of a portion of an instruction sheet covering the loading of 10-cm. shell, 1915 pattern, is given:

"In order to make certain that the bottom of the charge fits closely against the bottom of the shell a thin pencil streak of asphalt varnish should be made on the bottom of the charge. When the charge is placed into the shell, turned about, and then removed, a streak on the bottom of the shell will indicate whether the charge fits properly. If it does not another charge is to be selected. The varnish is removed, the selected charge held ready by one workman while the second workman pours into the shell 0.14 liter of the well stirred liquid paraffin-talcum mixture. The first workman then allows the charge to slide slowly into the shell and presses it firmly with the hand, and turns it around so that it will touch the shell bottom at all points. The charge is pressed down with the hand until the mixture has become a thick liquid but not altogether hard. Care should be exercised that the paraffin mixture rises all around the shell wall so as to have the charge firmly set in position. A wood form is then introduced into the booster cavity through the opening in the shell so as to line the charge properly. The space between the wall of the shell at the nose, and the upper part of the charge should be filled with the paraffin mixture. The head (or cap) is next screwed into place by hand as rapidly as possible."

Although detailed instructions were issued for the loading of each type of shell with these cartons, faulty loading occurred occasionally at most depots and led to a considerable number of prematures in the field. One of the principal causes of the prematures was the failure of workmen to fill in the small space which existed between the bottom of the charge and the base plug. In case of shell which were loaded by inserting the cartons at the base, a pasteboard disc was supposed to be placed in this space until the base plug pressed firmly against the disc. If the disc was a little thin and free space existed, of course ideal conditions existed for prematures as a result of set back. Cavities in the cast explosive within the

carton were also a source of difficulty just the same as they have always been when shell are loaded by direct casting; the carton method was no improvement in this respect.

Any discussion of special methods used by the Germans in loading shell would not be complete without including the scheme that was employed to effect complete detonation of certain shell which were loaded with explosives so insensitive that the standard boosters were not able to bring about the desired effect. It was common practice to extend the booster cavity 2-3 inches deeper into the charge than was necessary to provide space for the booster. The space was then filled with a pasteboard carton filled with pressed pieric acid. These small cartons of pieric acid were called *"Fullkorpers."* Pieric acid being easily detonated and an excellent booster explosive these *Fullkorpers* add ably to the action of the regular booster. As a matter of fact some of the shell, especially those loaded with the insensitive dinitrobenzol were provided with a central core of TNT or pieric acid which reached entirely from the booster to the base of the shell —an excellent booster system for comparatively insensitive explosives.

There were certain other features of the German methods of loading shell, which were departures from the more or less standard practice of other countries. These are in general relatively unimportant since they were prompted undoubtedly by the exigency of the time. Among them, might be mentioned the practice of leaving an empty space of appreciable volume at the nose of point-detonating shell. In such shell an unusually long booster was used so that it passed through the empty space and on into the charge. This method of loading was adopted in 1917 after certain experiments as to the suitability of the method were carried out. It was claimed that no effective action was obtained from the nose of a shell when a delay fuze was used, the fragments from the nose only burying themselves in the earth; hence it was unnecessary to have the explosive charge extend up into the nose of the shell. However, it is fairly certain that the main purpose of this method of loading was to conserve explosives. The saving effected in case of 15-cm. shell ranged from 150-300 grams of explosive for each shell, or about 20 per cent of the normal charge. This saving, while small, was not to be ignored toward the latter part of the War when the maximum effort of the explosive industry in Germany was scarcely able to supply the demand for artillery ammunition.

G. C. HALE.

COMMERCIAL

Caterpillar Tractor Company

ALL of the assets and rights of The Holt Manufacturing Company, of Peoria, Illinois, and Stockton, California, and of the C. L. Best Tractor Company, of San Leandro, California, are being purchased by the Caterpillar Tractor Company, a new corporation organized under the laws of California, with an authorized capital stock of $12,500,000.00, the principal business of which will be that of manufacturing and selling the combined product of the concerns included in this merger.

The Board of Directors of the Caterpillar Tractor Company will consist of C. L. Best, R. C. Force, B. C. Heacock, O. L. Starr, of San Leandro, California, P. E. Holt, of Stockton, California, Allen L. Chickering, Harry H. Fair, John A. McGregor, of San Francisco, California, and Murray M. Baker, of Peoria, Illinois. The official staff will be as follows: C. L. Best, Chairman of the Board; R. C. Force, President; Murray M. Baker, Vice President; P. E. Holt, Vice President; B. C. Heacock, Vice President and Secretary; and O. L. Starr, General Factory Manager.

The combined sales of the two constituent companies for the year 1924 were approximately $17,500,000.00. Trade indications at the beginning of this year point to a largely increased volume of tractor sales for 1925, and the sales to date amply confirm these indications.

"Caterpillar" and "Track Layer" tractors have become standard equipment in many important industrial activities, particularly in the fields of road building and maintenance, contracting, grading, logging, snow removal and agriculture. During the period since the war, the quality of these tractors has materially broadened and their use is rapidly extending into many new fields of activity throughout the entire world.

The new company will own the following plants:

(a) The Holt Manufacturing Company, Peoria, Illinois, a plant occupying 40 acres of land, of which 14 acres are under roof. A plant fully equipped for the manufacture of 5,000 "Caterpillar" tractors per year.

(b) The C. L. Best Tractor Company, San Leandro, California, a plant occupying 10 acres, of which 5½ acres are under roof. Fully equipped for the manufacture of 2,500 "Track-Layer" tractors per year.

(c) The Holt Manufacturing Company, Stockton, California, a plant occupying 21 acres, of which 12 acres are under roof. Equipped for the manufacture of Combined Harvesting Machines and for the manufacture of miscellaneous parts and sub-assemblies.

These properties will be owned by the Caterpillar Tractor Company, in fee, and constitute one of the largest, most efficiently equipped and operated combined facilities in the world for the exclusive production of tractors of sizes applicable to military, industrial and agricultural purposes.

The National Rifle Matches

THE National Rifle Matches and the matches of the National Rifle Association will be held at Camp Perry, Ohio, August 22 to September 20, inclusive. The usual rifle school will be held for two weeks and the N. R. A. matches shot from September 4th to 12th, inclusive.

An innovation this year, which should prove popular, is that of having all the national matches in the last week grouped as follows:

Monday, Sept. 14—National Individual Pistol Match.
Tuesday, Sept. 15—National Team Pistol Match.
Wednesday, Sept. 16—National Individual Rifle Match.
Thursday, Sept. 17—National Team Rifle Practice.
Friday, Sept. 18—National Team Rifle Match.
Saturday, Sept. 19—National Team Rifle Match.

This will give all day Saturday for the 1000 yard stage of the match, permitting it to start as late as 9:30 A. M. if visibility is poor and leave "get-away" day for Sunday, September 20, so that riflemen will not have to get up before daylight to turn in property and get fatigued before shooting the classic stage of the big match.

Book Reviews

John A. Brashear. Edited by W. Lucien Scaife. New York: Houghton, Mifflin Co. 1925. 262 pages. $4.00.

ANYONE who ever knew "Uncle" John Brashear, will want to read anything in print which he has said without any recommendation from others. The few occasions on which I have had the pleasure of his friendly recognition, I count as great moments in life,—this one above all others:

With considerable effort and much help from friends, I had assembled over one hundred and thirty West Point graduates in the ballroom of the Moana Hotel in Honolulu to celebrate the one hundred and fifteenth anniversary of the founding of the Military Academy, but I was not satisfied that the entertainment and speeches scheduled for the evening would provide adequate amusement to the enthusiastic diners. Passing through the lobby, my attention was called to the unmistakable figure of Uncle John, who happened to be on a return journey from Japan. I spoke to him at once of the gathering of many of his old friends, for we called him "Professor Emeritus of Astronomy at West Point" during and after the many years he lectured there. His eyes sparkled with enthusiasm, and he attended the dinner. No one will forget the glorious speech he made offhand, straight from the heart, a speech of love, of patriotism, of glorious enthusiasm for the Service to which we had all dedicated our lives. I am sure many of us were rededicated there under the spell of his magic words, and we gave him a "Long Corps Yell" that brought the tears to his fine old eyes. Those who were present that night will already have read his autobiography, I am sure. I need not speak of it to them.

To those hundreds of thousands, who could not have known him, in spite of his enormous acquaintance, and particularly to those among them who look upward on clear nights at the shining firmament and wonder at the stars, I desire to have him present himself through his smiles and tears as he recounts his life struggle in his splendid book. For he has gone now to what he calls so often "The Summer Land." His book, though, is John Brashear all through.

Some friend of his, I know it must have been Mr. Ambrose Swasey, made him promise, he tells us, to write some reminiscences of his long life. The American Society of Mechanical Engineers—this must have been its Secretary, Calvin Rice—demanded this service for the sake of future engineers. And on the veranda of his cottage at Muskoka Lake, we can see him, looking upward into the blue, and gathering the stories of himself and "Ma," of himself and all the noted scientists of this and the former century, into a continuous tale of how he lived and why.

To those who desire to classify him in their little social registers according to ancestry, he tells what he remembers of the beginnings of his family in America. It is not very much and takes few words. But he does remember with tender emotion grandfather Smith who taught him the stars and made them real to him through Squire Wampler's telescope.

His early life is an odd one for a great scientist. He studied bookkeeping and packed spokes. He almost studied for the Methodist ministry, but instead served the old time apprenticeship, through three years to journeyman and later to master mechanic in a machine shop. In some shops this training might be considered for value received more than the equivalent of a college degree. He served with the Snowdens and with Zug and Painter in the various grades of his trade, made engines for Ohio River steamers and helped set up the waterworks in Louisville, Kentucky. He must have learned the machinist and rigger's work most thoroughly. Otherwise he could not have ground such perfect lens surfaces as were demanded by the great telescopes. Today we often say we see beauty in irregularity and imperfection. Not so John Brashear. Perfection only was perfect beauty to him, and the most beautiful thing of all was a long look through a perfect telescope lens into the depth of the perfect heavens, filled with God's bright stars.

Would you not expect such an admirer of beauty to be a lover of music? He not only loved it, but he sang well himself and Mrs. Brashear, with a fine soprano voice, sang with him. When people came to their house, and they came often and in numbers, there were not only the stars through his fine homemade telescope, but there were the best songs and splendid music. When the Brashears visited the Henry Brothers, the astronomers of Paris, many years later, they found in their parlors a Mason and Hamlin melodeon at which they sat down and sang together Stephen Foster's melodies. The Henrys never forgot that wonderful evening of stars and songs through many later years of correspondence. I note in his letters to the Hoxies (in the back of the book the publisher added all the letters he could find), he widens his title for the hereafter to "The Summerland of Song."

With all the stargazing and the singing, one never loses sight of the fact that Uncle John is essentially a master mechanic. Though he rises at five-thirty to get to his work and does not return until six in the evening, he finds that Ma has set up the lathe and the grinder for a little pleasant work in their own shop after supper, grinding a lens or fabricating the tube and fixtures for the new telescope that will bring the stars a little nearer. With their own hands and the help of their friends, they built a house and a shop of their own, using all of their hard-earned cash. Wouldn't you know it would be on top of a hill! That home and the little shop is now a shrine for scientists, who have learned the secrets of the stars by the aid of John Brashear.

It was in this little shop that he and Ma worked out the process for silvering the great reflecting mirrors, the

Brashear process. There, in two hours and a half, they silvered the great seventy-two-inch reflector of the Dominion Observatory at Victoria, B. C. The big hundred-inch reflector at Mt. Wilson is done by his process. But how he gloats over his own twelve-inch mirror and tells of that wonderful first night with it when the Star Cluster in Perseus and Albireo in Cygni came into his house in such beautiful brilliancy.

By 1880, at the age of forty years, John Brashear gave up the machine shop to become an astronomer, at least, a master mechanic of astronomical instruments. The great Langley was then in charge of the Allegheny Observatory and was already a great friend and co-worker. William Thaw, the Pittsburgh philanthropist, through Langley, became interested in and supported Brashear's work with perfect lenses. He helped him to realize his ideal, as he expresses it, "to make the work turn out good," by frequently relieving the financial worries.

Already his work has attracted wide attention. It is now under Thaw's help, to astonish and delight the scientific world. He raised spectroscopy from the qualitative to the quantitative stage by the perfection of his plates for Rowland's ruling. How the master mechanic chuckles when Rowland, having found with his Steinheil test planes the Brashear plates untrue, is shown by the simplest mechanical test that the planes are untrue, not the plates.

In the old Latin readers, we recall the patrons of art who helped for arts sake alone the struggling young poets and writers. In this way, William Thaw found the young John Brashear, struggling to produce a better lens with which to see the stars, without distortion or achromatism, nearer than they had been seen before. Thaw helped him and received his everlasting thanks. He should receive ours also for giving John Brashear the means to broaden for us our little universe and to teach us the worlds beyond our solar system. Andrew Carnegie learned of the success of John Brashear and gave much toward the projects in Brashear's fertile brain. When he founded the various Pittsburgh educational institutions that bear his name, he asked Uncle John to prepare the plans for his structures and methods of teaching. Mr. Frick gave him a quarter million dollars with which to improve the grade schools of Pittsburgh. Many others who desired an honest, enthusiastic, sympathetic man of great foresight and knowledge to use their funds for the betterment of mankind, came to Uncle John to act as their guide and agent.

Yet with all this work outside the labor of his shop and outside his lectures and writing, he found time to talk to his neighbors, to bring them to his house, his telescopes and reflectors and to explain to them the mysteries of far-off shining worlds greater than our own. He found time to take Ma off to Muskoka Lake in Canada for her health and his, to plan and secure a launch, to seek flowers, to know the birds and to sing up there in the clear air and perfect scenes of the untarnished wilderness. Between whiles, he wrote this splendid story of his own life struggles, too short to tell us all because life was not long enough in eighty-four years to finish all he had in mind, but so sincere, so true and so inspiring that it should never go to the bookcase, but be kept on the table by the easy chair under the reading lamp for frequent use.

CHARLES G. METTLER

A History of American Privateers. By Edgar Stanton Maclay. New York: D. Appleton and Co. 1925. 519 pages. $3.00.

THE publishers are to be congratulated on reprinting this standard work on that departed phase of our national war activity at once so romantic and so productive of real results. It is romantic not because it belongs to a mode of warfare no longer practiced, but because of the colorful and strenuous nature of the calling, the vicissitudes of which brought into play all the attributes of a brave and resourceful warrior. Any one who in his youth laid aside *Robinson Crusoe* for Captain Marryat's *The Privateersman* and was held enthralled by the succession of hair-raising adventures of Sir Musgrave, will not be disappointed in the perusal of Maclay's account of our seamen warriors.

Maclay can draw vivid word pictures and, as in his other seafaring volumes, the scuppers run with blood and our side wins—often against great odds. But it must not be inferred that these scenes are not authentic, for the author's careful scholarship and painstaking inquiry of original sources are everywhere evident.

One of the most interesting careers sketched is that of Silas Talbot, a Captain in one of the Rhode Island regiments raised during the Revolution. He had had seagoing experience and with this and an intrepid spirit, he helped drive the English ships out of the upper Hudson and captured, in a surprise attack, the British ship guarding one of the approaches to Providence, thus earning his commission as Major. General Gates then gave him command of the ARGO, with twelve 6-pounders and sixty Army volunteers (most of whom had been seamen) for the purpose of putting a check on the Tory privateers sailing from New York. In several successful cruises this "Army" privateer took twelve prizes, including both Tory and English privateers, with three hundred prisoners and kept open the southern part of the New England coast, receiving from Congress the rank of Captain in the Navy.

But all was not victory and success. The privateersman of the Revolution endured privations at Old Mill Prison, Plymouth, similar to those inflicted on his Army brethren on the prison ship *Jersey* and during the War of 1812, the horrors of Dartmoor were the lot of those who fought a losing fight on the high seas. The tale of our merchant-warriors is a thrilling one which must not be allowed to pass into oblivion, for in it are contained all the outward signs of a hardy, venturesome race—deeds of courage, sportsmanship and resourcefulness. We who inherit their history may well review those episodes which made them such a potent factor in our military efforts of the past.

Were Maclay alive today, he would probably have preferred to delete the few passages which are relevant only to the years in which the work was first printed, but this does not detract from the historical value or interest of the subject matter. It remains a book which will amply repay the reader in both information and entertainment.

It is one of those fascinating historical volumes with an appeal which is not limited to our own day and generation. We predict for it a constantly increasing number of friends and admirers.

Admiral de Grasse. By Canon Max. Caron. Boston: The Four Seas Company. 1924. $2.50.

IT is a surprising commentary on the history of international relations that the sacrifices and help of one people for another are so soon forgotten or lost in the turmoil of subsequent events. That the relation of mutual help, existing between France and our own country during the Revolutionary War should ever be misinterpreted—as it is today—is a status which few certainly at that time would have ever dreamed of. Nevertheless, today we have eminent leaders both in political and private life who claim that our obligation to the French has been amply repaid for all her help during the Revolutionary period and that the accounts are now balanced; having in mind, of course, the help which was given that nation by our own during the World War.

In the final analysis this is probably a proper topic for personal interpretation. After all, whether or not a debt is ever repaid fully and completely depends upon the feelings of the parties to it. Help given in time of need may be repaid in kind pound for pound but the feeling of gratitude should never be forgotten.

If one would have a true conception of the invaluable help rendered by the French toward the freedom of the American colonies in 1776, this little book of Canon Max. Caron should be studied carefully not so much for what is said directly as for the broad inferences that are apparent to any thoughtful reader. The leading contributions of such eminent French soldiers as Lafayette and Rochambeau are generally known and frequently referred to. The importance of the aid rendered by Admiral de Grasse is not so often cited as a cause for thanks and yet the rôle of this worthy officer is quite as important as any of the rest. Had it not been for him and his timely appearance at Yorktown it is doubtful whether the victory would have occurred then—indeed it might have been indefinitely postponed. It was he who, with a fleet and a regiment of men, sailed from the West Indies to the Chesapeake and there delivered a telling blow which, in cooperation with Washington and Rochambeau, finally defeated the British.

The author's style of presentation is entirely free and frank. If anything, it has an academic turn that is not always of the most pleasing character. This, however, can be condoned in that the book is a translation from the French and much of its seeming awkwardness may be due to the translator. Then, too, there are certain elementary historical descriptions which, while giving a complete picture to the history of Franco-American relations and the settlement of America, are nevertheless foreign to the topic under discussion. Over and above these, however, is the story of a soldier, seaman and diplomat for whose services in our cause of freedom little has been said and little credit given. The life history of the man is romantic, and Canon Caron tells it in a fascinating way that should find a large audience here in America.

The Modern Executive. Compiled and Edited by Daniel Bloomfield. New York: H. W. Wilson Company. 266 pages. Indexed. $2.25.

THE MODERN EXECUTIVE is a group of essays and addresses on business management which the author claims to be the best available material on the subject. While one may question so broad a statement as this, still there can be little doubt that the material collected and made available in this small volume is of the very best. The articles stimulate thought and open new fields of endeavor which perhaps have not occurred to all executives. In most cases, if not all, the articles have previously been published in magazine form.

All are aware that few industries are managed in precisely the same manner. Each executive has his own ideas as to the proper road to success. One manager may believe an executive should be entirely free from details, while another may feel that a successful executive must know all the details but be capable of eliminating those not bearing directly upon the policies under his determination. It is a privilege in a book of this kind to have presented the many viewpoints together with the supporting arguments so that the reader can determine for himself which is the better course to pursue.

It must not be assumed, however, that there is always a difference of opinion such as that indicated above, for on fundamental principles there is a surprising degree of uniformity among all executives. For example, all agree on the need of a well-developed organization and the necessity of securing the free and lasting goodwill of employees. Most anyone, it is pointed out, can make a present good record at the expense of a future loss. Excellent hints to success are freely offered, from which we begin to appreciate and to understand the problems of management.

Much has been written of recent date on "human engineering." It is generally acknowledged that our schools do not turn out men trained to direct the work of others. In this volume an attempt has been made to train men along such lines through giving them as a text-book the best available material on the subject. Needless to say, such help will be welcomed by the earnest student as well as by those men already in the fields of management. Industrial leaders must be continually acquiring new knowledge as public conditions change and a new relationship is created between capital and labor, and there is perhaps no better way to keep abreast of the times than to read and study the observations and experience of others.

It should be clearly understood that this volume is not the work of one man, but the short articles or papers of many men successfully serving as officials of well-known industrial establishments, which have been assembled by the author under five headings as follows: (1) Place of Executive in Management, (2) What is Executive Ability? (3) Developing Executive Ability, (4) Work of the Executive, (5) Foreman as an Executive.

The book contains a bibliography and an introduction by Meyer Bloomfield.

Daedalus or Science and the Future. By J. B. S. Haldane. **Icarus or The Future of Science.** By Bertrand Russell. **Tantalus or The Future of Man.** By F. C. S. Schiller. New York: E. P. Dutton & Company. 1924.

THESE three essays should be read at the same time, preferably in the order listed. All three books deal with the future of man, particularly with his relation to science. They are short and all of them can easily be read in one evening.

"Daedalus" shows the wonderful things that science is going to do for us. "Icarus" is devoted to the evils which are likely to be encountered by future man as a

result of science, while "Tantalus" makes plain that the evils which threaten the future of man by reason of science are quite easily avoidable.

In "Daedalus," Mr. Haldane claims that the biologist is the controlling factor of the future of science in its relation to the history of humanity, and that purely technical and political forecasts of the future are inadequate. The author recalls that Mr. Chesterton, in a book written fifteen years ago, prophesied that hansom-cabs would still be in existence a hundred years hence, owing to a cessation of invention. Actually, within six years of the prediction, there was a hansom-cab in a museum. With regard to Mr. Wells, he points out that in 1902 Mr. Wells predicted that by 1950 there would be heavier-than-air flying machines capable of use in war. Mr. Haldane proposes to make no prophesies rasher than these.

It will be remembered that Daedalus in Greek mythology was a lengendary sculptor and architect of Athens and Crete. He is most famous as the father of Icarus for whom he designed wings. Icarus, in a flight with his father, fell into the sea when the sun melted the wax that fastened his wings. Daedalus, therefore, is the inventor of the act of flying and might be called the first great inventor inasmuch as he can be considered as the inventor of glue, even if it were not a very good quality, as well as flight. Mr. Haldane whimsically considers Daedalus as the first biologist, in view of his experience with the minotaur. The author believes the history of mankind to be intimately connected with the application of biological invention of which he lists six, four being before the dawn of history, and two in our day, one of the latter being bacteriacide.

Mr. Haldane fancifully pictures the biological invention in the future of a plant called, "The Purple Alga," which is an enormously efficient nitrogen fixer and will grow in any climate. It is so efficient as a fertilizer that a world-wide food glut is produced. The Alga escaping to the sea and multiplying prodigiously changes the color of the sea from the well known blue to purple. The fish learn to eat it and become so common that even England is self-supporting.

In "Icarus," Mr. Russell pictures eugenics as producing types desired by whoever is in power at that time. These types may not necessarily be desirable. The average intelligence may increase, but exceptional intelligence will be on the wane. He thinks eugenics likely to produce a subservient population. He does not believe the progress of science as necessarily a boon, as science at the present time contains a great many undesirable elements, such as increasing the power of the ruler. He does not consider science as a substitute for virtue.

Mr. Russell believes that science threatens to cause the destruction of civilization by giving men more power to indulge their collective passions: for example, the World War. The author particularly shows the danger which may arise from the exploitation of science. He traces the power of the press and the influence of propaganda, official and otherwise. He foresees the unification of the world under a nation or a group of nations, probably despotic and militaristic.

In "Tantalus," Mr. Schiller shows the achievements which man has made in the past, due to knowledge and civilization. He ascribes these achievements to social institutions, which may not necessarily be true of the future, since these institutions themselves may be corrupted by a deteriorating race. The author believes in eugenic reforms to reverse the dangerous physical influences of civilization. He thinks that the human race will be brought to realize that its habits and policies must be changed to conform with the facts of natural law.

The author of "Tantalus" interprets Daedalus as the collapse of civilization under the strain imposed on its moral fibre by material progress. He considers Icarus as man's inability to use the powers of the air and therefore ventures into science, without crashing. He believes it possible to gage the probability that history would repeat itself still further, and that man would once more allow his vices to cheat him of the happiness that seems so clearly within his reach.

This, of course, is not a new idea, as civilization may have reached a very high plane only to lapse time and again in past millenniums. Will the present civilization continue to progress, or will it be destroyed and progress set back another 2,000 years?

Both "Tantalus" and "Daedalus" predict the possible collapse of civilization, due to the greater fertility of the less desirable members of the population in almost all countries.

These essays are food for thought and should be read by every intelligent person.

Callinicus, A Defense of Chemical Warfare. By J. B. S. Haldane. New York: E. P. Dutton & Co. 1925. $1.00.

DR. HALDANE'S book is written from knowledge gained through a close personal contact with chemical warfare from its beginning in 1915; it is apparent that his interest cannot have diminished in the ten years which have elapsed since the first experiences with "poison gas."

Dr. Haldane presents very strong ideas in favor of the use of modern chemical methods of warfare, in which troops are rendered temporarily unfit for service without involving casualities at all comparable with those resulting from the use of shrapnel or high explosive shell. Contrary to popular opinion, this method of warfare is shown to be much more humanitarian than the older methods.

A word must be said about the interest which Dr. Haldane has maintained throughout his book. His story is replete with anecdotes, and it is doubtful if any one will start the book without finishing it at a single reading. It is a little volume of some eighty pages, and the reader can obtain a rather intimate idea of the principles of chemical warfare in an hour and a half of pleasant reading.

The Order of Military Merit. Exeter, N. H.: Society of the Cincinnati in the State of New Hampshire. 1925.

THE Society of the Cincinnati in the State of New Hampshire has brought forward a very interesting bit of history concerning the Order of Military Merit and the purple heart badge which is of unusual interest not alone because of its importance during Revolutionary times but because of its quaint historical significance.

Founded August 7, 1782, the Order of Military Merit was established by General Washington as a means of award for "Veteran non-commissioned officers and soldiers of the army who have served more than three years with bravery, fidelity and good conduct," and, as an-

(*Continued on page 846*)

Recent Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

Ammunition

FRANK A. FAHRENWALD has been granted patent No. 1,526,701, for a projectile. The object of the inventor was to produce a rotating band for projectiles which would not alloy or corrode the barrel of the gun, and for this purpose the band is made of an alloy of aluminum and a small percentage of a hardening metal preferably having an atomic weight between 55 and 64.

Patent No. 1,528,266 was granted to Lea W. Rockwell, for a safety percussion fuze. The claims of this patent cover a fuze containing a movable striker, and an ignition device normally held in a position so far forward of the striker that it can not contact with it, but adapted on rotation of the shell to screw back into position to be contacted by the striker. A shear pin is used for holding the ignition device in its normally forward position.

E. J. T. Wennerstrom has been granted patent No. 1,529,000, for a fuze for projectiles. In this fuze the detonator is normally held unarmed with respect to the primer by a ring, which ring on setback compresses a spring so that after acceleration ceases the spring forces the detonator forward and in so doing contacts a plunger to release the plunger from engagement with a centrifugal safety pin which normally holds the striker in unarmed position.

Ernest C. Moriarity, an employe of the Navy Department, has been granted patent No. 1,521,664, for a projectile. This patent covers a projectile having an annular groove in the base in which there is a filler, the groove extending forward beneath the rotating hand groove, so that the rear of the shell will strip off without causing a fracture extending into the explosion chamber.

Patent No. 1,530,336 has been granted to E. J. T. Wennerstrom for a releasing arrangement at primer safety device in fuze for projectiles. In this fuze the detonator is normally maintained in unarmed position with respect to the primer by means of a ball fitting in sockets in the fuze body and detonator casing and held in such sockets by a disc in the rear end of the detonator casing. A plunger is actuated on setback to drive the disc out of the rear end of the detonator casing and thus release the locking ball from the sockets, when the detonator casing will be free to be moved forward by a spring which is normally under compression.

Patent No. 1,531,624 has been granted to William K. Richardson for a projectile. This patent appears to cover a projectile having an ogival head with a plurality of vanes on the head, said vanes having specific characteristics as set forth in the patent.

Leon E. Remondy has been granted patent No. 1,531,716 for an apparatus for transmitting the firing to the charge in projectiles of elongated shape. This patent covers a projectile having a forwardly extending tubular member in which are maintained a plurality of firing members or fuzes each fuze being operated only by ramming in and inertia, the gases generated by the firing of a fuze acting to fire the next subsequent fuze.

Leon E. Remondy has also been granted patent No. 1,531,717, for a percussion fuze for aircraft bombs and other purposes. This patent covers a fuze in which there is a slow burning train or element and a quick burning element which may be ignited thereby, the same being so arranged that the slow burning element is ignited on light impact and the quick burning element on heavy impact or vice versa.

Patent No. 1,532,355 has been granted to Chas. P. Watson for a percussion fuze. This patent covers a fuze having a weakened portion in the body thereof whereby side blows will tend to break the fuze in such portion instead of deforming the same, the aperture parts of the fuze still being in position to function properly. It further covers a specific form of fuze having a special form of turret bolt or safety device therein.

Frederick W. Bold, assignor to Charles H. Pearson, was granted patent No. 1,531,628 for a fuze. This patent covers essentially a safety device for mechanical time fuzes which is alleged to positively prevent premature starting of the timing mechanism. Said mechanism can only be released by the shock of firing the shell from a gun.

Frederick W. Bold, assignor to Chas. H. Pearson, has been granted patent No. 1,532,369 for a fuze. This patent covers a specific form of locking means for a mechanical time fuze.

Artillery

PATENT No. 1,526,538 is granted to Hannibal C. Ford, assignor to Ford Instrument Company, Inc., for a range finder. In this range finder the variable relation between the angular movement and the indicated range at the range finding station is rectified, and such rectified motion, which is directly proportional to the ranges indicated, is transmitted to the receiving station.

Paul Kaminski, assignor to Siemens & Halske, Aktiengesellschaft, has been granted patent No. 1,526,551, for an apparatus for determining the motion of an object from a moving platform. In this apparatus an epicyclic or planet wheel gear is employed, the first driving wheel of which is adjusted in correspondence with the motion of the platform and the pinion planet wheel of which is adjusted in correspondence with the total distance difference, so that the other free wheel of the gear performs

a motion corresponding with the difference of the two beforementioned values.

L. E. Schubert has been granted patent No. 1,527,086, for a means of measuring distances and altitudes. In this invention two measuring instruments are employed situated at a known distance from each other, each instrument carrying a sighting means and an angle measuring scale and a device for reading the angular scale of one instrument from the other.

Patent No. 1,527,317 for an apparatus for effecting gunnery calculations has been granted to Y. P. G. Le-Prieur, assignor to Societe Anonyme La Precision Moderne. This invention relates to a device which shows in an automatic and instantaneous manner upon suitable dials the modified range and lateral allowance to be used, after having set upon various other dials the estimated or measured values of the factors affecting the firing.

A. Barr and W. Stroud, assignors to Barr & Stroud, Ltd., were granted patent No. 1,528,191, for a range finder, height finder, inclinometer and the like. This instrument is so constructed that a small auxiliary adjustment in elevation of the relative positions of the separating line and the images of the target in the field of view may readily and easily be made by the observer without moving the body of the instrument, such adjustments being a fraction of the field of view and perpendicular to the supporting line.

A. T. Dawson, G. E. Watt and A. L. Perham, assignors to Vickers Ltd., have been granted patent No. 1,529,-172 for a means for use in the laying of ordnance. In this invention the indicator is in plane view of the gun pointer and is provided with two indicator arms which must be kept in coincidence by the gun pointer in traversing or elevating the gun.

Patent No. 1,530,445 has been granted to H. E. Warren, assignor to General Electric Company, for an automatic synchronizing apparatus. The object of this invention is to automatically overcome the angle of lag which is usually present in an instrument controlled by movement of another instrument.

Small Arms

PATENT No. 1,525,458 for a rifle sight guard has been granted to R. J. Manion. This guard is made up of a flexible cover which fits over the sight and has a stiffening member secured thereto and an elastic band secured to the ends of the cover and adapted to encircle the rifle to retain the cover in place.

L. E. Wurtzbach has been granted patent No. 1,525,-846, for a silencing device for firearms. This silencer has a spring held longitudinally movable core therein, which core is provided with spirally arranged grooves communicating with the bore of the core.

A. G. Schlosser and W. N. Elton have been granted patent No. 1,525,892, for a method and means for strengthening or reenforcing gunstocks. In this invention the weakened portion of the gun stock has spaced slots cut therein in which slots reenforcing metallic plates are inserted and fastened to the stock by riveting or otherwise.

L. Fritz has been granted patent No. 1,526,847, for a rifle. The inventor has provided a series of recesses in the rifle stock, each recess of proper dimension to receive a cartridge magazine, means being provided for holding the magazine in place within the recess.

H. O. Russell and L. J. Eyler of McCook Field have been granted patent No. 1,528,950 for a cocking handle for aerial guns. The object of this invention is to provide an attachment for a gun of the Browning type which will permit the operator to cock the gun from the left-hand side.

H. O. Russell of McCook Field has been granted patent No. 1,530,702 for a sear and sear release for machine guns. In this structure there is provided a vertically sliding sear which when released is moved from engagement with the firing pin by cooperating cam surfaces upon the sear and firing pin. A sear release normally engages a lug on the sear to hold the sear in engagement with the firing pin, said release being moved transversely of the bolt to release the sear.

Chas. Sutter, assignor to Societe Anonyme Des Anciens Etablissements Hotchkiss et Compagnie, has been granted patent No. 1,531,044, for a firing mechanism for automatic firearms. This invention contemplates providing a firing mechanism through means of which a continuous firing or single shot firing may be had and which also permits of setting to safety position in which position the gun may be cocked but no shot can be fired.

Book Reviews

(*Continued from page 844*)

nounced in General Washington's order of August 7th given out at Headquarters, Newburgh, New York, "for this purpose a narrow piece of white cloth of an angular form is to be fixed to the left arm on the uniform coats; non-commissioned officers and soldiers who have served with equal reputation more than six years, are to be distinguished by two pieces of cloth set in parallel to each other in a similar form. Should any who are not entitled to these honors have the insolence to assume the badges of them, they shall be severely punished. On the other hand, it is expected that gallant men who are thus designated will, on all occasions, be treated with particular confidence and consideration."

The badge of military merit of the Continental Army was of purple sprigged silk, faded to a steel grey, edged with a narrow binding, originally silver.

So far as the investigations of Mr. John C. Fitzpatrick, Assistant Chief, Manuscript Division, Library of Congress, have been able to determine, the badge was awarded to only three recipients, all of them non-commissioned officers: Sergeant Daniel Bissell, of Captain David Humphrey's Company of the Second Connecticut Regiment of the Continental Line; Sergeant William Brown, of Captain Samuel Comstock's Company of the Fifth Connecticut Regiment of the Continental Line; and Sergeant Elijah Churchill, of the Fourth Troop of the Second

Regiment Light Dragoons, which was recruited in Connecticut.

The booklet gotten out by the Society of the Cincinnati describes, as accurately as the records indicate, the acts of bravery on account of which the recipients were awarded the decoration.

The publication of such interesting data by the Society of the Cincinnati is a further indication of the important patriotic work which this venerable organization is performing and is likewise a unique account of army activities during the Revolutionary War which, as in most other cases, is a tribute to the stalwarth qualities of the Commander-in-Chief, General Washington.

Charles Proteus Steinmetz—a Biography. By J. W. Hammond. New York: The Century Company. 489 pages. 1924.

IN June, 1902, Dr. Chas. W. Elliot, President of Harvard University, in conferring the degree of Master of Arts on Steinmetz, made this memorable statement, "I confer this degree upon you as the foremost electrical engineer in the United States and therefore in the world." Such was the phenominal rise of a youthful engineer, who fourteen years prior to this date had found it necessary to leave Germany because of his outspoken socialistic views, and who after a year's sojourn in Switzerland had come to America, penniless and unable to speak the English language, and had entered the service of a New York firm at two dollars a day.

A man who could attain so great an honor in so brief a time, and a year later have conferred upon him the degree of Doctor of Philosophy by Union College would be expected to have a most interesting biography, no matter by whom written. Mr. Hammond has taken full advantage of this setting, and not content with merely stating facts, has added color and pathos to his story of this "world builder" as he terms him, thereby elevating him nearer to the place he should hold in public opinion.

The first chapters of the book deal with the early life of Steinmetz in his rural home in Germany. In these chapters the author develops the fact that Steinmetz was a spoiled child—spoiled through the love of his grandmother who reared him in his father's home, his own mother having passed on in his infancy.

Following the story of his early boyhood comes a detailed account of his schooling and of the indications of his brilliant mind. In closing his career at the University of Breslau he was acknowledged its greatest student, but was denied his Doctor's degree on the eve of his graduation because of certain radical views previously referred to. Thus one is better able to understand why in later life this man was an ardent supporter of the conservative wing of the American Socialist Party.

In biography style is important. A thread of interest must be woven throughout the pages, and yet accuracy of fact must be the first consideration. The pages must not be dull and prosy no matter how ordinary the subject-matter. All this the author has realized and, with a natural gift for character sketching, he has given us a story of one of the world's great men which will be enjoyed by all who read it.

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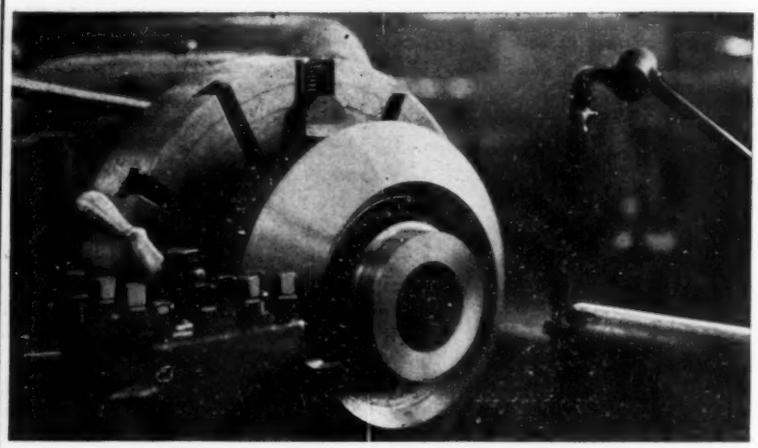

on a Warner & Swasey turret lathe at the PITTSBURGH GEAR & MACHINE CO.

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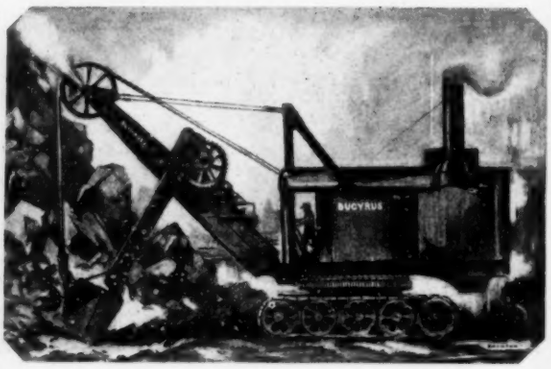

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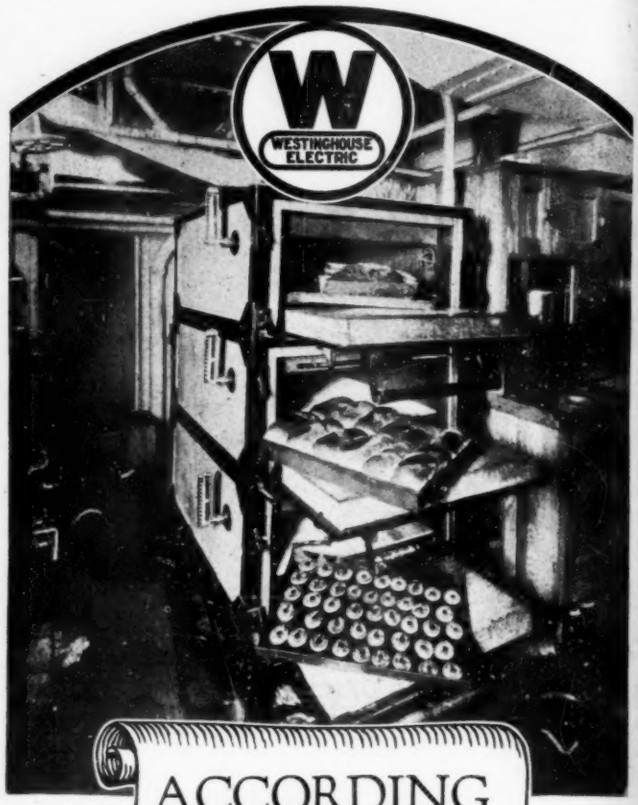

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